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UGANDA PROTECTORATE.

ANNUAL REPORT

OF THE

DEPARTMENT OF AGRICULTURE.

(PART II.)

FOR THE

Year ended 30th June, 1939.

PRICE: SHS. 3.

Published by Command of His Excellency the Governor.

ENTEBBE:
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REPORT ON THE WORK OF THE ENTOMOLOGICAL SECTION.

(i) REPORT OF THE SENIOR ENTOMOLOGIST.

Medical entomological work continued under the writer's supervision until December 20th, when the primarily agricultural part of the section and the remainder of its equipment were transferred to the new experiment station at Kawanda.

Apart from two brief visits to Serere (July and September) for the initiation and checking of work on cotton insects, Dr. Taylor's time was devoted almost exclusively to the investigations of the coffee bug. This work is along new lines and cannot be regarded as overlapping in any way the studies in progress in other East African territories; considerable progress has been made and the results are given in Dr. Taylor's interim report.

The investigations of cotton pests at Serere were designed as a continuation of the work carried out during previous seasons. The routine observations and counts which form the basis of Mr. Stephenson's report (of necessity, mainly statistical) were done very ably by Mr. Mubbiru, African Agricultural Assistant, aided by one observer. Mr. Stephenson, who arrived on first appointment late in October, took charge of the entomological work at Serere and during the short remainder of the cotton season became sufficiently familiar with the crop and its insects to enable him to suggest lines of future studies.

Other investigations at Serere included a continuation along the lines of previous years of the counts for *Dysdercus* population, and estimations of pink bollworm incidence.

The figures obtained for *Dysdercus* followed closely those of the two preceding seasons. A tendency for groups of nymphs to congregate on the bunds was noted and at one period there appeared to be far more *Dysdercus* on the bunds than had until then been seen on the cotton on the Main Farm. By the time the stainers moved on to the cotton three-quarters of the crop had been picked.

The monthly figures obtained for pink bollworm indicated an increase in the infestation of bolls from 1% in September to 10% in December on the Main Farm. Late in December in the same area an estimate was made of the total damage by caterpillasrs to bolls: of 3,000 bolls examined 50% had been destroyed but only 3% of this damage was due to pink bollworm most of it being consequent on attack by *Argyroploce leucotreta*.

Mr. Stephenson carried out a survey in January to ascertain whether pink bollworm had spread into Usuku County of Teso. A total of 1,500 green bolls, consisting of samples of 50 taken at intervals of three miles, were examined and showed no evidence of the pest; field examinations likewise gave negative results. The sample bolls were remarkably clean and showed only 2·9% and 8% infestations respectively, of *Argyroploce* and *Earias*.

Examinations of cotton by Dr. Taylor mid-September showed that pink bollworm was already very common at Bugondo in plots near the ginnery (14% flowers infested); this was to be expected since old cotton plants had been left standing. At Mulondo, two samples of each of fifty bolls indicated an infestation of about 6%. If the resting larval stage occurs at all in this area it must be very rare; otherwise the pest would have been far more common at the time of these examinations. In Bugishu at the end of November, samples examined near Bubulu proved negative for pink bollworm.

Advisory.

Advice was given on insects attacking banana, beans, books, buttons, *Cassia siamea,* coffee, cotton, decorative plants, Eucalyptus, fruit trees, groundnut, lawn grass, millets, "muvule" (*Chlorophora*), oil palm, sweet potato and teak.

Miscellaneous.

Beekeeping.—The section's African Instructor resumed demonstrations of wax extraction and preparation in Acholi District (Gulu section) in November, continuing until late April when he was transferred to Lango for similar duty. During the course of the demonstrations in the former area, two men of local tribes acquired knowledge of the methods to enable them to continue the work among their own people.

The year's purchases of beeswax on behalf of Government in northern Mengo amounted to 207 lbs. only.

Plant Protection.—A total of 201 packages of imported plants were inspected; of these, two were fumigated and one (blue sisal bulbils) was planted for growth in quarantine. During the three months ending mid-June other consignments of imported plants were dealt with by the Senior Agricultural Officer, Kampala.

Kawanda mosquitos.—Two brief surveys were carried out under dry and wet season conditions of possible sources of malaria vectors within the boundaries of the experiment station, and recommendations were made for dealing with the few important breeding places discovered. Mr. G. H. E. Hopkins undertook identificattion of some of mosquitos obtained.

Termite Investigation.—An enquiry was instituted into the extent of damage, the materials affected and the methods adopted for preventing damage by termites. The assistance of the Forestry, Posts and Telegraphs, and Public Works Departments was invited for the supply of information and specimens concerned with their respective fields of interest. Concurrently, a survey of termite species occurring in Uganda was initiated.

Publications.—"The Usefulness of Entomological Collections in Agricultural Institutions" by T. H. C. Taylor (*East African Agricultural Journal, IV,* 1939).

"Notes on Some Pests of Maize and Millets in Uganda" by H. Hargreaves (to appear in *East African Agricultural Journal*).

Visiting Entomologists.—Mr. A. R. Melville, who had been making a study since March, 1938, of the factors controlling mealy-bug in Uganda with a view to introductions of parasites into Kenya, spent a final week at the laboratories in November.

Capt. C. Smee of Nyasaland spent three weeks in this country to obtain information on insect pests and on the conditions under which crops are grown.

Acknowledgments.—As in former years, the Imperial Institute of Entomology has rendered valuable assistance. In addition to officers of the Institute the following specialists identified insects for the section:—J. Bequaert, G. A. Bisset, C. L. Collenette, F. W. Edwards, R. Korschefsky, H. K. Munro, G. Nixon, H. Oldroyd, O. Parent, G. Soika, H. Stringer and R. G. West.

Locusts.

Review of Developments.

The outline given below under headings of the two species (*Nomadacris septemfasciata* and *Locusta migratoria migratorioides*) is a continuation of the account given in the report for the preceding year. The period under review was remarkable for the extensive infestation by *Locusta* which affected all districts (more especially those north of the equator), and for the subsidence of the *Nomadacris* outbreak which after January became confined to western counties of Toro.

Monthly summaries were compiled from district reports and issued to interested officials and organisations and to the press; after January, in consequence of the extended infestation by *Locusta,* the summaries were made to cover fortnightly periods. Maps showing distribution and developments of locusts were also prepared each month.

Nomadacris.—During the quarter July–September little change in distribution occurred, few flights being recorded and mostly in the old Western Province. Further egg-laying of a diffuse nature occurred during July and August in the Bugerere–Eastern Province area, and during October and November in south-western Toro and again in Teso during November, the latter being restricted to three areas of about one square mile each. Escapes from the eastern area reached the winged stage in September, October and November and most of the few swarms formed disappeared and apparently moved westwards to join their fellows in Toro: it was impossible to trace the movements of these swarms owing to the concurrent spread of *Locusta,* but the conclusion is based on evidence of unusual damage in north Mengo and Mubende districts during December in conjunction with the fact that *Nomadacris* did not move north or east from this breeding area.

In Toro, the hoppers became winged during the first three months of 1939 and larger swarms concentrated and remained during April and May in Busongora and Bunyangabo counties, particularly in the Ruwenzori foothills at altitudes from 4,500 to 8,500 feet. During June some swarms moved into Belgian Congo while others went north into Burahya and Bwamba counties; some of the latter matured and laid eggs in diffuse formation in the low-lying, sparsely inhabited flats of Lake Albert between the Semliki River and the northern end of the mountain range. The main infestation, however, remained in Busongora and these swarms were still immature at the end of June.

Damage to crops, which comprised *Eleusine,* maize, banana, bean, cotton, sweet-potato and cassava, was unimportant until March when the concentration of fliers in Busongora commenced to do extensive and serious damage to food crops in the foothill zone.

The Game Warden recorded the death of large numbers of winged *Nomadacris* in the Lake Edward game reserve of southern Busongora. The locusts were found clinging to grass and other plants over an area of several square miles during October, and although no specimens were forwarded it is almost certain that the fungus *Empusa grylli* was the cause of death.

Locusta.—The hoppers which survived from the initial breeding in West Nile became winged during July and August; during the latter month a few thin swarms in circling flight were observed in this district.

Early in August an influx of swarms of varied age from the north commenced and continued with a break only in September until February, 1939. The first swarm entered Karamoja from Kenya on August 3rd and the next entered Chua from the Sudan on the 4th; later that month several swarms came from the latter country into Madi and a general southerly movement commenced.

One swarm matured in September and laid eggs in north-east Bugishu. Egg-laying commenced in Madi, Chua, and Lango in October and extended during November into Teso, Mengo and Bunyoro. By this time some swarms had reached the districts south of the equator. Breeding occurred during December in West Nile (extensively) and on a restricted scale in Mubende and Ankole. In Eastern Province districts other than Teso and Bugishu, breeding first occurred in Busoga on a very small scale in January and it was followed by similar breeding in north-east Bugwere in February; further laying occurred at a few places in these two districts in March subsequent to the arrival of additional swarms from the north.

During March and April, consequent on the advent of the rains, swarm movement became much more frequent in West Nile and in districts north and east of the Victoria Nile. Some tendency to northward movement was shown temporarily in April; this resulted in a reduction of the infestation in Mubende, Bunyoro, Mengo, Budama, Bugishu and Bugwere but it also increased the intensity in more northern districts, especially Karamoja which until then had been almost free. In these northern districts and in eastern counties of Toro, breeding commenced late in April and continued through May.

Further southerly movement within the Protectorate took place in May. Swarms matured progressively and additional breeding occurred during May and June in Bugwere, Bugishu, Budama, Busoga, Mengo, Bunyoro and Mubende. In these areas the breeding was on a relatively small scale and of a diffuse type. Towards the end of June two mature swarms entered the north of Masaka District but no egg-laying was recorded.

Early in June in West Nile and Acholi (Madi, Chua and Gulu) and later in Lango and Teso, surviving hoppers began to reach the flying stage. The situation became less menacing in West Nile but more serious in the adjoining Madi sub-district.

Damage by *Locusta* to the end of January, though severe locally in some areas, was on the whole of little importance. During the following five months, *i.e.*, the grain growing season, extensive and serious damage was caused, at first by flying swarms and later by hoppers and young fliers. *Eleusine*, maize, sorghum, rice and banana were attacked; groundnut was affected to a negligible extent. The damage was most serious in West Nile,

Acholi, Lango and Teso, these districts having the most intense and protracted infestations.

Judging by the rarity of allusion to such factors in district reports natural enemies exercised an unusually small controlling influence and the effect was discernible only in areas of sparse infestation. Birds and the egg-parasite *Stomatorrhina lunata* did good work in certain areas; the nematode parasite was apparently rare. Examination of specimens of winged locusts from northern and eastern areas in April and May, undertaken with a view to determining the cause of suspected delay in reaching maturity, revealed the presence of a peculiar internal mite in most samples; these tracheal mites were not numerous and they appeared not to have had any marked effect on the fecundity of their hosts.

H. HARGREAVES,
Senior Entomologist.

(ii) REPORT BY DR. T. H. C. TAYLOR, ENTOMOLOGIST, KAWANDA.

Antestia.

The intensive investigation of *Antestia* which was commenced early in 1938, has been continued. It is impossible to draw final conclusions, except on a few minor points, from work which has covered only one complete coffee season, and the present report is to be regarded merely as an interim statement of the more important observations made to date and as an indication of the scope of the investigation.

Antestia has been well known for many years as one of the most serious pests of coffee in East Africa and has accordingly received much attention from entomologists. Most of the work done, however, has been directed towards the control of the insect in European-owned plantations, and is, therefore, scarcely applicable nowadays in Uganda, where coffee is becoming increasingly a crop for Africans. The conditions affecting *Antestia* in small, isolated, African-owned plots and those in large, European-owned estates, differ so greatly as to constitute two almost separate problems, and the need for further investigation of *Antestia* has arisen mainly in consequence of the recent extensive planting of *arabica* coffee by Africans in Bugishu, Ankole and Kigezi Districts. Moreover, the climate and vegetation of these districts, particularly the last two, differ considerably from those of the older coffee areas of the Protectorate, and it became necessary to ascertain the effect of all these new conditions together upon *Antestia,* which has appeared and firmly established itself in almost all parts of these newer areas, and to attempt to devise means of controlling the bug.

Test-spraying with pyrethrum-paraffin extract, as advocated in Kenya, has played an important part in the investigation. It is an excellent method for ascertaining the average population of *Antestia* or any other free-living insect on coffee. Since all free-living insects on the trees sprayed fall on to a sheet on the ground and are easily collected, the opportunity has been taken for making a general survey of coffee insects in the areas

concerned. It was felt, also, that it might be useful to learn what insects are normally associated with *Antestia* on coffee. This survey of the insect fauna of coffee has occupied much time. Only the Coleoptera and Rhyncota have so far been sorted and mounted, and these alone include more than five hundred species. Most of these are purely incidental on coffee and merely happened to be on the trees at the time of spraying. Separate records of the fauna have been kept for more than 200 trees, and the records are useful as an indication of the distribution of each species and the extent to which it frequents coffee. More than half of the species thus obtained cannot be identified in Uganda and have, therefore, been sent to the Imperial Institute of Entomology. Since so many species are undetermined no further reference to this survey will be made in this report.

Investigations in Kyagwe.

In order first to become familiar with *Antestia* in its old haunts and to obtain a basis for comparison with other districts, the writer spent five weeks in the Mabira Forest area of Kyagwe in May and June, 1938, and revisited the same area in September to repeat his investigations at a different time of year and, therefore, in different conditions as regards the stage of the coffee crop. Kyagwe was expected to provide information of special interest because it is an area where *Antestia,* although formerly a serious pest, has become a comparative rarity and quite negligible in recent years, and it was considered desirable to find out why the insect could no longer multiply sufficiently to cause appreciable damage. The special importance of Kyagwe as a possible source of clues to the control of *Antestia* was first stressed by the Senior Entomologist, who has known the estates there for many years and fully appreciated the change in the *Antestia* situation which has occurred

The Kyagwe coffee is chiefly in European-owned estates. Formerly it consisted mainly of *arabica* but recently the *arabica* has been largely replaced by *robusta,* which is more suitable for the comparatively low altitude of the area. This change accounts for the present scarcity of *Antestia* in many places, since the insect does not thrive on *robusta.* In many other localities, however, there are still considerable areas of *arabica,* and in these also *Antestia* is uncommon and negligible. Much of the *arabica* is growing under old *Hevea* rubber which causes moderate shade, and most of it is very neglected, owing to the recent slump in prices. The trees have now grown up and produced long, lanky stems with sparse foliage, except at the top, and with little crop. Extensive interplanting with *robusta* has taken place, and the *robusta* trees have now grown so large that they have almost ousted the *arabica* in some blocks, while in others the two species together form so dense a growth that, with rubber shade above, the conditions approximate to those of a forest. In many places, also, there is a dense and tall ground-cover of weeds for the greater part of the year.

The *arabica* coffee may, in fact, be said to be growing almost in forest conditions, and if we regard *Antestia faceta,* which is the only coffee-feeding species present in Kyagwe, as an insect indigenous in Mabira Forest, as it almost certainly is, it is not difficult to understand why it has become uncommon in an area in which it was formerly a pest. Any forest insect feeding on wild Rubiaceae is well controlled in its natural habitat by the

scattered distribution and partial concealment of its food supply, and by natural enemies. The latter are accustomed to shade, absence of wind, high humidity, and abundant soil moisture, and have, in all probability, several alternative hosts which feed on certain of the plants comprising the weedy undergrowth and which therefore enable the natural enemies, predators as well as parasites, constantly to be present. It is not surprising, therefore, that *Antestia* becomes abundant when one of its preferred food-plants, notably *arabica* coffee, is planted in pure stand, without constant ground-cover, and is maintained (by pruning and absence of shade) in the form of relatively dense bushes with foliage and crop concentrated. These are most unnatural conditions for the trees, although desirable from the planter's point of view. In such circumstances *Antestia* is completely removed from the environment, climatic and biological, in which it is naturally controlled, and it is provided with an abundant and readily available food supply in the form of berries (which it prefers to shoots) and with ample shelter within the trees owing to their compact growth. There is no shelter on the ground for natural enemies, and often too little moisture near the surface of the soil to enable those enemies which enter the soil for pupating to mature.

These observations in the Mabira area are very suggestive, but whether the scarcity of *Antestia* in the partially abandoned estates is due mainly to the lanky, open type of tree, or the ground-cover, or the general shadiness, or the influx of natural enemies from the forest which adjoins all the estates in question, it is not at present possible to decide. The probability is that the scarcity is due to a combination of all these factors, the natural enemies being the direct cause and the other factors acting indirectly by making the conditions in the estates so similar to those of the forest that the natural enemies can spread from the forest and survive in places where they were formerly unable to do so. It would be foolish to suggest that in order to control *Antestia* we must permit the coffee and weeds to grow without restraint until forest conditions prevail, but it is not unlikely that partial reversion to such conditions, by ensuring a permanent ground cover, possibly in the form of mulch, and by adopting a pruning or shading system which results in less dense shelter within the trees, would suffice.

By no means all of the *arabica* blocks in Kyagwe have been abandoned to the extent of those just described. It is true that the Mabira coffee area, considered as a whole, can be said to have reverted to partial forest conditions, but there are several estates where the trees are still maintained in good condition, on ordinary estate standards. In these, also, *Antestia* is uncommon and negligible, but enquiry reveals the fact that clean-weeding is a comparatively rare occurrence nowadays even in these better tended estates, and this is probably a most important point in the control of *Antestia,* as in that of other insects on other crops. In any case, the new conditions in the area as a whole can be expected to influence these small, better tended blocks also, particularly if insect enemies are the direct controlling factors, as observations made in 1938 indicated.

Investigations of the natural enemies in Kyagwe are to be included in the 1939–40, programme, and until these have been completed it is useless to speculate further as to the value of the Kyagwe observations of last year.

An estimate of the *Antestia* population per *arabica* tree in the Mabira area in June was obtained by test spraying. The mean figures were 1·6 (nymphs and adults) and 0·8 (adults only). The insect was present everywhere, but in only about 30% of the trees. In September it was rarer than in June, although berry food suitable for it had been plentiful continuously for about five months.

Investigations in Bugishu.

Three months at the end of 1938 were devoted to a study of the *Antestia* situation in Bugishu. This district afforded an opportunity for observing the activities of the insect on coffee at elevations varying from 4,500 to 7,000 ft. All the coffee (*arabica*) of Bugishu is grown in small plots, except for a few communal areas (at Bulucheke, Bukigai, Bupoto, and Magale) which cover several acres. The plots are in almost all conceivable situations—on the flats at the bottoms of valleys and on steeply sloping hillsides, in very exposed and very sheltered places, in forest country and in open short-grass country—so that there is every opportunity for observing any preferences which *Antestia* may have. Mulching is extensively practised, but in very many plots the condition of the trees is bad, owing principally to lack of pruning and to irregular cropping, and undesirable types of tree which provide *Antestia* with ample shelter are present in almost all localities. An energetic campaign designed to encourage and improve pruning was launched by the Agricultural Officer during 1938, and this is important from the point of view of *Antestia,* though its precise effect cannot be predicted.

In 1937, *Antestia* was abundant in all parts of Bugishu, but the only figures available are those obtained by Mr. A. M. Gwynn, then Entomologist, Serere, at Bugusege Experiment Station, where the population per tree in one experimnt of 40 plots varied from 6 to 122 adults with an average of about 40, and in the Bulucheke Valley, where it varied from 3 to 23 and the average was 13·5. In 1938, the corresponding figures for Bugusege were 0 to 8 with an average of 1·3, and for the Bulucheke Valley 0 to 13 with an average of 4·0 (which, though low, contrasts strikingly with 0·8 for Kyagwe). There is no doubt that throughout Bugishu (except at the highest elevations) there was less *Antestia* in 1938 than in 1937. Previously, it had steadily increased from year to year. But there is no reason to suppose that the pest will continue to decrease. The decrease is almost certainly attributable firstly to the fact that the 1938 crop was much less than that of 1937, many plots at the lower altitudes having practically none, and secondly to the activities of natural enemies (mainly parasites of the eggs) the efficiency of which increases with the *Antestia* population until a peak is reached when almost total parasitism prevails. The evidence at present available suggests that the *Antestia* population will increase and decrease periodically, though not markedly, and that the peak population will not be high (probably below 20 adults per tree), but will be sufficient to cause serious damage. The severe outbreak at Bugusege in 1937, was certainly abnormal. Such outbreaks are liable to occur anywhere; but they will be rare since the egg-parasites are ordinarily capable of suppressing their host before very high populations are reached, although not before considerable damage is done. The very low population at Bugusege in 1938, was an expected and natural reaction from the severe outbreak of 1937. The poor crop of 1938 could not support a high population, but it was sufficient to support far more *Antestia* than were

actually present. The primary factor in the reaction was almost certainly egg-parasites. Evidence for this was available in the few old egg masses which were still to be found on the leaves. Every egg in every batch had an exit hole of a parasite, but even without this evidence analogy with other insects which occur in similar outbreak form elsewhere would have left little room for doubt on this point.

At Bugusege late in 1938, *Antestia* was present in almost all plots of all experiments, but in only 30% of the trees, and this distribution corresponded with an average population of 1·3 adults per tree. In the Bulucheke Valley it was present in 93% of the trees, with a population of 4·0 adults per tree. In the Bupoto area (including Magale) about 95% of the trees contained *Antestia,* and the population of adults averaged 4·8. There is probably a correlation between the distribution (among trees) and adult population, provided crop and foliage are nearly uniform.

In the Bulucheke Valley and the Bupoto area (except above 6,000 ft.) the insect was very generally distributed. There was no indication that degree of shade or situation influenced it. The only obvious factors affecting the *Antestia* population were amount of suitable crop and degree of shelter within the trees (not to be confused with overhead shade). In general, the plot with most crop had most *Antestia,* provided only that there was considerable shelter within the trees from foliage.

The writer had hoped that the Bugusege experiments would prove suitable for obtaining information as to the possible effect on *Antestia* of the various ground treatments and shade, when crop and foliage are plentiful. Unfortunately this was impossible, not only because the crop was poor and the *Antestia* population extremely low, but also because it was found that the plots are so small that when one is dealing with so active an insect as *Antestia* the edge-effect covers almost the whole of each plot.

The altitude limit of coffee in Bugishu is 7,000 ft. Below about 5,500 ft. *Antestia* is present and common almost everywhere. Above 6,000 ft. it is usually absent. But it is gradually spreading upwards. It was present in the highest plots (6,200 ft.) on Namisandwa (above Bupoto) and also in one plot out of ten which were test-sprayed close to Butandiga at 6,800 ft., but it was rare in both of these localities and had almost certainly only just reached them. Between Bulago and Buginyanya, however, in the Sisi Valley, there is a plot at 6,200 ft. where *Antestia* is known to have been present for several years, and where it is now abundant. This plot is of special interest. There is little doubt (judging from the evidence of Africans) that *Antestia* reached it in 1934–35, when there was almost certainly none elsewhere above about 5,500 ft. In 1938 every tree in this plot was a mass of foliage and completely devoid of crop, the insect (presumably) having caused dense tertiary branching by attacking the terminal shoots. This type of damage is well known, but was very rare throughout the areas visited during the investigation, except in very slight and negligible form, the damage being almost entirely confined to the crop. Many of the insects remained and bred in this plot despite absence of crop, and despite the presence of abundant crop in other plots nearby. It is likely that the extreme form of tertiary branching was due simply to the complete failure of the owner to prune or attend to the trees in any way after he had found that *Antestia* was ruining his crop. And since it is

known that the insect ordinarily deserts trees without crop for those with plenty, it may be concluded that the abundant vegetative proliferation which was apparently due to its own activities provided it with suitable food, although in normal trees crop is preferred and sought.

The extent of spread of *Antestia* from this particular plot was investigated. The insect was found in all plots above and below the original one on the same side of the valley and had crossed the river at the bottom to coffee on the other side (less than half a mile away) but it had not spread far up the other side and was entirely confined within this one valley. This is important because there is a general belief that *Antestia* multiplies and spreads very rapidly. Actually, it is very reluctant to move, and there is every indication that it does not become common enough, in a new locality, to be noticed by the growers until two years after its arrival.

There is no reason to expect that the higher altitudes, in Bugishu or elsewhere, will prove unsuitable for *Antestia*. The insect appears to thrive at all altitudes at which coffee is grown. In this respect it differs from *Stephanoderes,* which has an altitude limit, very clearly marked, at 5,000 ft.

Throughout Bugishu, samples of 50 or 100 fully-grown, but still green, berries were collected in every plot in which test-spraying was carried out. All the berries were then cut transversely and the damage, if any, apparent in each bean was recorded under one of three headings, according to the nature of the damage. It was soon realised, however, that although it was easy to recod and classify the damage, it was impossible, very frequently, to decide whether it was due to *Antestia* or not. The three types of damage were: firstly, the bean locally discoloured, but hard and not shrivelled; secondly, the bean black, decayed and shrivelled; and thirdly, the bean shrivelled, hollow and almost without endosperm, but without blackening. The first two types of damage were due to *Antestia,* since they were absent in almost all localities where *Antestia* was not found and were present everywhere else. The third was certainly due to *Antestia* in many cases, but equally certainly not in all; and since it was always present in localities where *Antestia* was proved by test-spraying to be rare or absent, though always in a smaller percentage of beans than in localities where *Antestia* was numerous, the numerical data obtained must be interpreted with caution. This last type of shrivelled bean, in which little more than the endocarp (parchment) remains, is undoubtedly, in many cases, a physiological phenomenon. It is known that it results from nitrogen deficiency. It probably arises from a great variety of factors which result in unhealthy trees, and certainly it also arises from over-cropping.

For these reasons almost the only conclusions to be drawn from the 4,000 berries examined are that the percentage of completely sound beans (not berries) below 5,500 ft. was 58 and above 5,500 ft. was 89. The percentages for the various localities varied from 28 to 80 below that altitude, and from 55 (in a plot in the Sisi Valley where *Antestia* was present) to 98 above it. At the higher altitudes, the percentage of completely sound beans almost invariably exceeded 90. This difference between the higher and lower altitudes was not entirely due to *Antestia,* since the trees at the higher altitudes were in much better condition, and

also younger. It is possible to obtain a *minimum* figure for the percentage of beans damaged by *Antestia* at the lower altitudes by summing the first two kinds of damage. This works out at 17. The true figure is probably nearer 30, but it is important to remember that this means that 30% of the beans are damaged by *Antestia,* not that 30% are destroyed by it.

There has been a tendency in Bugishu to assume that all shrivelling of beans is due to *Antestia.* Consequently the damage done by it, although considerable, has been exaggerated.

Throughout Bugishu, the species of *Antestia* is *faceta. A. lineaticollis* is entirely absent. *A. faceta* is probably indigenous in Bugishu, in the forests of the lower altitudes. At the higher altitudes, its presence in coffee is almost certainly due to spreading from lower coffee plots.

Investigations in Ankole and Kigezi.

The type of country in which coffee (*arabica* and *robusta*) is grown in Ankole and Kigezi differs greatly, on the whole, from Kyagwe and Bugishu, which are mainly forest areas. Much of the coffee in Ankole and Kigezi is grown in country which consists mainly of grassy hills, devoid of bush, or in open scrub country. In both districts the coffee industry is still in its infancy and the plots are few and far between, while the various coffee areas are separated, in many cases, by many miles of country which is very sparsely populated and therefore almost uncultivated. At first sight, the hills of Ankole and Kigezi appear most unsuitable for coffee. Nevertheless, heavy crops are produced in many localities. Since, in many cases, the coffee trees are still young, and young coffee usually yields well and looks well, it is at present too early to judge the suitability of the country. The environment is new for coffee in Uganda, and it is correspondingly new for insects which can feed on coffee.

For several years, only *arabica* coffee was planted, and plots of *arabica* are now present at altitudes varying from 4,500 to 6,500 ft. In recent years, however, *robusta* coffee has been distributed for planting. The reason for that drastic change is *Antestia,* which probably prefers *arabica.* The insect has appeared in almost all areas of Ankole and Kigezi and has done great damage in many. Nevertheless, it seems undesirable that an insect should be permitted to dictate in so vital a matter of policy, especially as *arabica* and *robusta* have never been experimentally compared in the areas concerned. The very few old *robusta* trees which exist suggest that *robusta* may grow and yield reasonably well at the lower elevations, but it is almost certain that the two districts, as a whole, are more suitable for *arabica,* and it would be most dangerous, in spite of *Antestia,* to extend *robusta* to higher elevations without careful experiment and until the possible methods of checking *Antestia* on *arabica* have been thoroughly tested.

The need for a thorough investigation of all aspects of the *Antestia* problem is, therefore, very urgent, not merely because of the damage done on *arabica,* but also because of the desirability of permitting the climate and soil of the areas concerned, rather than *Antestia,* to be determining factors in the choice of the species of coffee to be grown.

It is remarkable that *Antestia* is now present in all localities in Ankole where coffee is grown. With many miles of uncultivated country separating certain of the coffee areas and a distance of a mile or more often separating

plots, it would not be surprising if there were still many localities not yet reached by *Antestia*. This, however, is not the case. Even in the most remote places, such as Ibanda in Mitoma Saza, Gayaza and Lugaga in Ishingiro, Lugalama in Kazhara, and Chankalanga in Bunyaruguru, the insect is present. It is scarcely conceivable that it has spread to all of these isolated places from the nearest old-established coffee of Masaka or Toro District. In several areas, this would involve crossing twenty miles or more of almost uninhabited country. Further, the insect is not one which can often be carried accidentally by human beings, animals or birds. The only reasonable explanation, on the evidence at present available, is that it is indigenous in the bush, and is, therefore, already present wherever coffee is planted. This raises the question of alternative food-plants. Much attention was paid to this question by the writer, but without success. In Ankole the only common plants of the family Rubiaceae likely to support *Antestia* appear to be *Pavetta* spp. and *Pentas* spp. These were examined carefully in many localities, but no *Antestia* was ever found on them. Nevertheless, it is probable that the insect normally feeds on some wild plant, which, though common, is sparsely distributed and never concentrated and is without fruit for a considerable period of the year, so that the insect cannot multiply extensively and is normally maintained in a condition of rarity. The existence in Ankole of the parasite *Corioxenos,* whose host range is certain to be extremely limited, lends some support to this view.

It has already been stated that in Kyagwe and Bugishu *Antestia* is to be regarded as a forest insect. This does not conflict with the suggestion that in Ankole it is indigenous in the tree-less, grassy hills, because a different species is conerned. Throughout Ankole, except Bunyaruguru, the species is *lineaticollis* and *faceta* is entirely absent. In Bunyaruguru, *faceta* is present everywhere and *lineaticollis* is absent. Bunyaruguru differs from the whole of the rest of Ankole* in that it is volcanic and contains numerous patches of forest comparable to that of Kyagwe. It is isolated by natural barriers from all other coffee areas. To the north and west the Kazinga Channel and Lakes Edward and George separate it from Toro, and to the south and east almost equally formidable barriers exist in the form of the Lubare hills (up to 6,000 ft.) and the Kalinzu and Kasyoha Forests. There is little doubt that here, as elsewhere, *faceta* has invaded coffee from the forest. The only point which is difficult to explain is that it has not spread southwards from the Kalinzu and Kasyoha Forests into the territory already occupied by *lineaticollis*. The two species do not occur together anywhere. If it be assumed that *faceta* occurs in the small patches of forest in Bunyaruguru, one must assume that it occurs in the two large forests also. Its failure to appear south of the Lubare hills is presumably due simply to the fact that it has not spread in all directions at the same time; and this, after all, is not surprising, especially since its rarity in all coffee plots of Bunyaruguru suggests that its spread even in that area is recent.

There are a few gombololas in Ankole (*e.g.,* Musale and Mutuba II in Kazhara) where *Antestia* either has not been found or else has just recently been noticed for the first time. This has given the impression that it is

*Except a very small area at Katunga, six miles north of Bushenyi. This area is volcanic and includes a crater lake, but is too small to differ greatly in fauna from the surrounding country. The species here is *lineaticollis*.

spreading from some unknown source. Enquiry shows, however, that until about 1936 there was practically no coffee in bearing in these gombololas, and even now one can often walk for several miles without seeing any. Moreover, as previously stated, *Antestia* is seldom common enough to be observed and reported by the local inhabitants until at least two years after its arrival. On the whole, therefore, the probability is that in these gombololas, as elsewhere, *Antestia* is already present in the bush and is entering the coffee plots from the bush, but not until after they have commenced bearing. This point is stressed because references to the "spread" of *Antestia* are common and may be misleading, and because the true facts are important in connection with control by stumping. Actually, it is exceptionally reluctant to spread (*i.e.,* to fly long distances). In the Sisi Valley of Bugishu (already referred to) it has taken at least two years to travel half a mile, and it often remains largely confined to a few trees in a single small plot for more than one season. Statements to the effect that *Antestia* has suddenly appeared in large numbers in a new area, as though it had migrated, are invariably wrong.

In Kigezi, the *Antestia* situation is similar to that of Ankole. The species concerned is again *lineaticollis* only, except in the volcanic area of Bufumbira where *faceta* is the only species present. *Antestia* is now present in the coffee in all counties and almost throughout the district. It is most severe in the northern counties where it is present in every plot. In some localities of Ruzumbura and Rukiga it is damaging 100% of a heavy crop of berries and is causing wholesale stumping of coffee to be carried out. The bug has appeared progressively southwards, and this has caused the impression that it has spread from north to south, across high hills and extensive tracts of country devoid of coffee. This may be true, in which case the insect has utilised wild plants in its spreading. But the evidence available again points to the probability that it is indigenous almost throughout the district. The vegetation is more varied in the south, and therefore the wild food-plants, which must be assumed to be present in the grassy hills of the north, may well be less common in the bush in the south. If this is true, the insect would appear in coffee more slowly in the south than in the north.

The occurrence of *faceta* in the volcanic area of Bufumbira is of great interest, since the only other saza where this species occurs in Ankole and Kigezi is also the only other volcanic area (*i.e.,* Bunyaruguru). The volcanic part of Bufumbira has no forest comparable to that of Bunyaruguru, and none at all except at high elevations on the volcanos, but there is much in the adjoining Belgian territtory. At present *Antestia* exists in only one plot in the volcanic part of Bufumbira (*i.e.,* near Nyarusiza). It was first noticed in a neighbouring plot in 1938, which means that it first arrived in 1937, or earlier, but this plot was immediately stumped and is now free from *Antestia.* The stumping caused the insects to depart to the next plot, which is the one in which it is now thriving. In this particular case, though not in any others, it is almost certain that the insect was introduced by human agency from the adjoining Belgian territory, where the species present is *faceta,* as in volcanic Bufumbira. The main track to the Congo passes between this plot and the stumped one, and labourers returning from work on the Congo plantations use it constantly.

The only other locality* in Bufumbira where *Antestia* occurs is near Kinanira, north-west of Lake Mutanda. This remote and isolated outbreak is far from the volcanic area, and the species concerned is *lineaticollis*. There is therefore no connection between the two Bufumbira outbreaks.

In the last few years much attention has been focussed on the possibility of *Antestia* being controlled by reducing the acidity of the soil and therefore changing the constitution of the sap on which the insect feeds. This suggestion arose from the observation that *Antestia* was abundant on the acid soils of Ankole and Kigezi, but absent on the volcanic soil of Bufumbira and rare on that of Bunyaruguru. It was further suggested that *Antestia* was absent in Bufumbira because it could not live there. In the writer's opinion there is no evidence to support these suggestions. The evidence against them may be summarised as follows:—

(1) *Antestia* is flourishing in Bufumbira, and in the neighbouring Belgian territory (and also on Mt. Elgon).

(2) *Antestia* is present in every plot in Bunyaruguru. It is uncommon probably because it has not yet had time to become common.

(3) The species of *Antestia* in the volcanic areas is distinct from that of all the other areas in these two districts. The natural habitat of one is probably forest and that of the other is not, and they occur in the areas to which they belong. Comparison of the effects of different soils is meaningless in these circumstances.

(4) In several non-volcanic localities of Ankole and Kigezi *Antestia* is absent only because it has not yet arrived, or rare because it has only just commenced to breed on coffee.

(5) In the experimental plots at Rukungiri and Kebisone, in each of which three ground treatments (clean-weeding, mulch and ashes, and mulch only) are being tested for their effect on *Antestia*, the percentage of sound beans was far higher in the clean-weeded plots than in the others. All the plots had a very heavy crop and showed no appreciable differences in amount or colour of foliage, or in general growth. *Antestia* was abundant at Rukungiri and common at Kebisone. The percentages of sound beans were as follows:—

	Clean-weeded.	Mulch and Ashes.	Mulch.
Kebisone	90	45	43
Rukungiri	34	16	19

At present, however, no final conclusions can be drawn, since the experiments have been in progress for only three years.

Since the *Antestia* populations in most localities where the insect is present in Ankole and Kigezi were much higher than in Bugishu, and the damage correspondingly greater, the figures obtained by examination of berry samples from all plots test-sprayed indicate more accurately the damage done by the insect. The shrivelling of beans due to physiological causes, however, was again common and indistinguishable from similar shrivelling due to *Antestia*. This type of shrivelling was noticed in areas where *Antestia* is certainly absent, but was much more common where the insect itself was common. Undoubtedly *Antestia* is one cause of it, but it is not the only cause. In the following table the figures for the separate localities are combined under counties.

*Test spraying near Kirwa, Bunagana, Kisoro, Mabungo, Nyakabande and Mashongera gave negative results.

ANTESTIA AND DAMAGE ON ARABICA COFFEE IN ANKOLE AND KIGEZI.

County.	*Antestia* (Nymphs and Adults) per tree.			*Antestia* (Adults only) per tree.			Percentage of Beans locally damaged by *Antestia*.	Percentage of Beans rotten and useless owing to *Antestia* attack.	Percentage of Beans shrivelled and useless, but not rotten (partly due to *Antestia*).	Percentage of Beans sound.
	Max.	Min.	Average	Max.	Min.	Average				
Bunyaruguru ..	6	Nil	0·8	4	Nil	0·6	2·9	1·0	2·4	93·7
Igara	49	Nil	13·6	32	Nil	6·2	5·6	6·9	9·8	77·7
Kazhara	102	Nil	13·6	83	Nil	10·9	10·6	3·8	7·9	77·7
Bufumbira* ..	Nil	Nil	..	Nil	Nil	..	..	..	4·3	95·7
Ruzumbura ..	123	Nil	20·3	70	Nil	11·8	8·2	8·1	22·6	61·1

*Not including the one plot where *Antestia* is present.

These figures are based on examination of 6,000 berries and the test-spraying of 200 trees, in 50 localities. It is most important to note that in Igara, Kazhara, and Ruzumbura (especially the latter), many plots have been stumped because of *Antestia,* and these obviously are not included in the figures, which therefore greatly underestimate the damage done. The percentage of shrivelled, but not rotten, beans in Bufumbira (in the absence of *Antestia*) is 4·3; and in Ruzumbura (in the presence of *Antestia* in abundance) it is 22·6.

As in the case of the Bugishu figures, no attempt has been made, or will be made, to analyse statistically the data obtained from individual plots and trees. Three of the most important factors concerned in determining *Antestia* incidence (or that of any other insect on a permanent crop) are the past history of the trees (as regards crop in particular), the insect population in the previous year, and the *actual* amount of crop in the current year. Reliable information on these points can never be obtained from African growers.

It was noticed in Ruzumbura that an adult population of about 60 per tree results in 100% damage to berries and 90% damage to beans in large multiple-stem trees bearing a heavy crop. An adult population of 20 per tree in such trees does great damage but about 50% of the beans remain sound.

Although *Antestia* is admittedly a very serious pest, its severity is intentionally exaggerated by certain chiefs and many growers in Ruzumbura, and to a lesser extent elsewhere. It is used as an excuse for not planting coffee or for not looking after coffee trees which already exist. The people in question state that they do not want to plant coffee because *Antestia* destroys all the crop. The crop is destroyed because the people sit and watch it being destroyed and make no attempt to check the insect. The same people refuse to mulch their coffee because they say that when they try to control *Antestia* by "hand-picking" the insects fall into the mulch and are lost. This argument is merely pathetic. The fault is mainly with chiefs, but an additional difficulty is that the people are accustomed to annual food-crops only, and have little desire for permanent cash-crops or cash.

Control Measures.

It is not intended at present to recommend new measures for the control of *Antestia,* but a few notes on minor control measures already practised or tested may be of interest.

"Hand-picking" is practised with conspicuous success at Bwongera in north Kazhara, Mitoma in Igara, and Kayonza in south Kazhara. It is done regularly once a week, and the catches are brought to the local chief for inspection. It is probable that only 50% of the insects are caught, but to reduce the population from, say, 20 per tree to 10 per tree, is to reduce the damage greatly. Morever, the population is not merely reduced; it is maintained permanently at a low level. The benefit derived from this procedure is at once evident in the three localities named, and is emphasized by figures obtained from crop samples. The method, as practised by African growers and their families, costs nothing. All of the growers who say they do not want coffee because *Antestia* destroys all the crop could keep the insect within reasonable bounds by this simplest of all methods. It is a curious fact that most agriculturalists and horticulturalists, and not only Africans, dislike, and almost resent, being advised to control

pests by catching them by hand. They prefer costly chemical or biological methods. In the case of *Antestia*, the matter lies mainly with the chiefs. Keen and enterprising chiefs can induce their people to control *Antestia*. There is no need for expert advice. But unfortunately many years must elapse before it will be possible to persuade all chiefs and growers that they themselves are best able to control *Antestia*. Meanwhile, we must seek other methods.

"Stumping", that is, cutting the trees back almost to ground level, is widely practised in areas where *Antestia* is abundant. It is an obviously efficient control measure, but since it involves complete absence of crop for three years, and has to be repeated about every six years owing to the return of *Antestia*, it has little to recommend it, especially as judicious pruning and hand collection of the insects can be done almost equally easily. In extreme cases of neglect of trees, stumping is desirable in order that a good type of tree may be produced, but this is another matter. A slight elaboration of the stumping method, however, has been developed, quite unintentionally, in a few localities, and there is something to be said for it. Three adjacent plots of coffee of different ages are stumped in rotation, and the plot with the youngest trees, which is the one with the heaviest crop, is comparatively free from *Antestia* because the trees, being young, are of an open type which does not provide sufficient shelter for the requirements of the insect. This only applies in cases where lack of pruning results in conditions favourable to *Antestia* in the older trees. Such cases, however, are very common. The only advantage of this rotational stumping is that some crop is produced every year. An extreme modification of the method is rotational planting with rotational uprooting, the latter to be done when the trees have produced crop for about three years (*i.e.* when *Antestia* begins to attack them severely). If the present great difficulty in inducing growers to prune should continue, some such procedure would have advantages from other points of view besides that of *Antestia* control.

Spraying, especially with pyrethrum, has been advocated by several Agricultural Officers. Its possibilities have therefore been considered very carefully in each of the districts in which the investigations of the past year have been made. Several chiefs and African Agricultural Assistants have asked the writer to provide them with the necessary apparatus and pyrethrum or other spray. Enquiry has shown, however, that the procedure in spraying and the cost of it are very inadequately understood by most Africans. It is not realised that repeated sprayings will be necessary or that the kill is by no means 100%. Nor is it realised that Government is unlikely to provide apparatus and materials, or that the success with sprays on European-owned plantations has no connection with the present problem. The writer's experience with pyrethrum extract in paraffin has shown that a very heavy and thorough application, with each tree covered by a sheet, is necessary to ensure an adequate kill in the large, untended trees which are so common in the districts in question, and almost certainly annual application would be required. The work could be well done by a gang specially trained for the purpose, but only under constant supervision. If left to the growers it would not be done at all, except by one or two of the more enlightened people, and except at first when it would be an amusing novelty. Probably the greatest difficulty is the scattered

distribution of plots and the great distances which separate them. A gang would have to travel on foot, since few plots can be reached otherwise, and several gangs would be needed if the work were to be done at the right time. Also, extensive organisation and inspection by Agricultural Officers would be essential.

Spraying, then, as a general control measure for all growers, may be definitely and finally dismissed as being absolutely impracticable *in the special circumstances in which the coffee in question is grown.* There are certain individual growers who wish to spray and would spray thoroughly and with success, but even they are well advised to try hand-picking first.

Requests for arsenical baits have also been received, but these have been refused for obvious reasons.

The possibility of using a *Tephrosia* extract as a control for *Antesita* was considered to be worth examining, since the people are accustomed to preparing the water extract for control of lice and fleas in their houses. Furthermore, *Tephrosia* spp. (particularly *vogelii*) are common almost everywhere in Ankole and Kigezi, and the materials would therefore cost nothing. An African was instructed to make up the water extract of *T. vogelii* in the manner to which he was accustomed and the strength of the extract was then greatly increased for testing purposes. The strong extract was tested in the field as a spray, and also, when mixed with sugar, as a bait splashed onto the leaves. It was further tested in tubes and cages in camp as both a contact insecticide and a stomach poison. In the latter case, the insects were observed to feed on it. In all tests (including the last, which was surprising) the results were almost completely negative. These results confirmed those of tests made in Kampala in the previous year, and *Tephrosia* has accordingly been dismissed as useless in the present connection.

Robusta Coffee as a Food Plant for Antestia.

The question of the extent to which *Antestia* attacks *robusta* coffee is very difficult to answer on the evidence obtainable in Uganda. In Kyagwe, the replacement of *arabica* by *robusta* has been accompanied by a great reduction in the population of *Antestia* throughout the area; but since the reduction is almost as marked in the few *arabica* blocks which remain as in the blocks which were formerly *arabica* and are now *robusta* there is no doubt that the change to *robusta* is not the only factor concerned. From Kyagwe, therefore, we can obtain very little information on this question. Test-spraying in Kyagwe showed that the percentage of *arabica* trees containing *Antestia* is very much greater than that of *robusta,* and that almost all *robusta* trees are entirely without *Antestia.* But since the insect was extremely rare even in *arabica,* no accurate comparisons could be made. Large *Antestia* nymphs were found in two *robusta* trees in different localities in Kyagwe (one nymph in each), in circumstances such that it was practically certain that they could not have wandered from the nearest *arabica.* No adults or eggs were found on *robusta,* but the nymphs found left little room for doubt that *Antestia faceta* oviposits and and can mature on *robusta.* It is certain, however, that *arabica* is preferred.

In Ankole and Kigezi there is at present very little *robusta* old enough to bear fruit, and all of the few trees that are fruiting are mixed with

arabica. There is always some *Antestia* on *robusta* if *arabica* is severely infested nearby. On this account, and because the *robusta* and *arabica* trees in any one locality were never comparable as regards size, amount of crop, and other factors which affect *Antestia,* accurate comparisons were again impossible. Nevertheless, a few useful observations were made. In a small mixed garden at Kalalo in Igara (Ankole) there are a few *arabica* and a few *robusta* trees, all large, and all had much crop when examined. Two *robusta* and four *arabica* trees were test-sprayed. The *robusta* trees averaged 7 adults and 5 nymphs, and the *arabica* 16 adults and 4 nymphs. Eggs were found on the *robusta* as well as the *arabica*. About 30 yards away from this garden there is a plot which, until recently, consisted of old *arabica* trees with a few *robusta* in the middle of them. About six weeks before this inspection was made, the *arabica* trees were all stumped and only the *robusta* were left. These *robusta* trees were found to be full of *Antestia,* averaging 44 adults and 25 nymphs, and many of the nymphs were nearly mature. Eggs were common on the berries. There can be no doubt that the stumping of the *arabica* drove *Antestia* adults, and probably some nymphs, to *robusta,* but there was no reason why the adults should stay there, since there was plenty of *arabica* nearby in the garden, unless they found *robusta* suitable for their requirements. It was practically certain that *Antestia lineaticollis* (the species present in that area) was breeding normally on *robusta* in this plot and also in the garden. But there was no indication as to which species of coffee was preferred. A berry sample from the *robusta* trees in the plot showed 34% of the berries damaged by *Antestia* (*i.e.,* showing the type of damage which is always attributed to *Antestia*); in addition, a little of the usual shrivelling, which may or may not be due to *Antestia,* was observed.

In a small plot of a mixed *arabica* and *robusta* near Kibasi in Kazhara (Ankole), some of the former and all of the latter had much crop, and four of each, with much crop, were test sprayed. The *arabica* averaged 30 adults (including one tree with 83) and 9 nymphs, and the *robusta* 12 adults (including one tree with 32) and 0·5 nymphs.

A plot at Kichwamba in Ruzumbura (Kigezi) contained many small, stumped *arabica* trees with good crops, and four large *robusta* trees with heavy crops. The two *arabica* trees sprayed contained 4 and 5 adults respectively and no nymphs, and the two *robusta* contained 4 and 9 adults respectively and one of them had one large nymph.

The only other *robusta* seen in fruit was east of Kichwamba, near the Ankole border. These trees contained no *Antestia,* but neither did most of the *arabica* trees nearby, owing to stumping.

It must be remembered that the two species of *Antestia* may differ in the extent to which they can feed and breed on *robusta*. The writer has not yet found convincing evidence that *lineaticollis* prefers *arabica*.

Parasites.

The parasites listed below have been obtained from *Antestia* in the course of this investigation and in the areas specified:—

Attacking the Eggs:—

(1) *Microphanurus seychellensis,* Kieff. (Scelionidae). (Kyagwe, Bugishu, Ankole, Kigezi).

(2) *Microphanurus suranus,* Nixon. (Scelionidae). (Kyagwe, Bugishu, Ankole, Kigezi).

(3) *Hadronotus antestiae,* Dodd. (Scelionidae). (Ankole).

(4) *Anastatus bifaciatus,* Fonsc. (Eupelmidae). (Kyagwe, Bugishu, Ankole, Kigezi).

(5) An undetermined Eupelmid. (Kyagwe, Ankole).

(6) *Pleurotropis* sp.* (Eulophidae). (Kyagwe, Bugishu, Ankole, Kigezi).

Attacking the Nymphs:—

(7) *Helorimorpha coffeæ,* Brues. (Braconidae). (Bugishu).

(8) *Helorimorpha* sp. (Braconidae). (Bugishu).

Attacking the Nymphs, but Maturing in the Adults:—

(9) *Corioxenos antestiae,* Blair. (Strepsiptera). (Ankole, Kigezi).

Attacking the Adults, and occasionally the Nymphs:—

(10) *Epineura rubens,* Villen. (Tachinidae). (Kyagwe).

T. H. C. TAYLOR,
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*Almost certainly secondary.

(iii) REPORT BY MR. P. R. STEPHENSON, ENTOMOLOGIST, SERERE, ON INVESTIGATIONS OF COTTON PESTS.

Extensive Lygus and Jassid observations were made at Serere on the Sowing-date, Spacing and Cotton Variety Trial.

The varieties in the trial were follows:—S.G.29, used as a control; M.2, a mass selection from N.17; S.P.20 and S.P.84, both U.4.4.2. derivatives belonging to the S.P.13 group; S.P.93, a glabrous Nariama cotton; and S.P.102 which is a derivative of a natural hybrid, probably S.G.29 derivative × U.4.4.2 derivative.

Lygus.

Lygus samples were taken from the whole trial 8, 10 and 12 weeks after sowing and a damage count* was made 8 weeks after each sowing. The samples were taken by fifty sweeps with a net on each plot, each sweep covering one plant. Records were made of the typical *Lygus simonyi,* Reut, an undetermined green *Lygus* sp., and the *Lygus* nymphs collected.

*30 plants per plot examined by the method described in the 1936 report of the Assistant Entomologist, *Ann. Rep., Dept. Agric., Uganda,* Part II, 1936—37.

The following figures are taken from the analyses of these counts.

(*a*) *Varieties.*

LYGUS SIMONYI—PERCENTAGE OF S.G.29.

Date of Sample.	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
8 weeks after sowing ..	100	97·7	99·6	90·9	84·2	82·1	9·9
10 weeks after sowing	100	90·7	95·3	85·9	87·9	83·6	9·8
12 weeks after sowing	100	89·5	88·0	87·7	79·5	78·9	12·7
Weighted Mean of three samples ..	100	93·1	95·2	88·8	84·3	81·8	5·9

LYGUS SIMONYI PER 50 SWEEPS.

Date of Sample.	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
8 weeks after sowing ..	16·9	16·5	16·8	15·4	14·2	13·9	1·7
10 weeks after sowing	15·6	14·2	14·9	13·4	13·7	13·1	1·5
12 weeks after sowing	11·0	9·8	9·6	9·8	8·7	8·6	1·4
Weighted Mean of three samples ..	14·5	13·5	13·8	12·9	12·2	11·9	0·9

GREEN LYGUS SP.—PERCENTAGE OF S.G.29.

Date of Sample.	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
8 weeks after sowing ..	100	136·2	95·2	79·1	61·9	93·3	41·6
10 weeks after sowing	100	92·1	99·1	62·5	67·4	84·8	24·7
12 weeks after sowing	100	80·8	80·2	68·5	64·7	68·5	17·3
Weighted Mean of three samples ..	100	94·3	93·1	67·9	66·3	79·8	15·8

GREEN LYGUS SP. PER 50 SWEEPS.

Date of Sample.	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
8 weeks after sowing ..	2·2	3·0	2·1	1·7	1·4	2·0	0·9
10 weeks after sowing	6·8	6·3	6·8	4·3	4·6	5·8	1·7
12 weeks after sowing	7·2	5·8	5·7	4·9	4·6	4·9	1·2
Weighted Mean of three samples ..	5·3	5·0	4·9	3·6	3·5	4·2	0·8

LYGUS NYMPHS—PERCENTAGE OF S.G.29.

	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
Weighted Mean of three samples ..	100	108·6	119·6	94·3	76·9	70·1	15·8

LYGUS NYMPHS—PER 50 SWEEPS.

	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
Weighted Mean of three samples ..	2·6	2·8	3·1	2·4	2·0	1·8	0·4

LYGUS DAMAGE COUNT—PERCENTAGE OF S.G.29.

Date of Count.	Variety.						L.S.D.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	P=0·05
8 weeks after sowing ..	100	95·9	94·8	91·3	88·9	80·0	4·75

The *Lygus* numbers are expressed as a percentage of S.G.29 to bring them into line with the damage count. The numbers per 50 sweeps are given to indicate the extent of infestation.

The resistance exhibited by S.P.102 is remarkable; in the 1937–38 season it showed significantly less damage than S.G.29 but this is the first season in which sufficiently extensive samples have been taken to give significant differences in the population figures. The slight difference in the behaviour of *L. simonyi* and the green species is worth noting but otherwise the figures for the various counts conform closely.

The north side of the trial was bordered by a plot of Sorghum and it was anticipated that the population would be greatest on that side, but no such difference could be detected.

(*b*) *Sowing-dates.*

Weighted Mean of three samples for	Sowing-date.				Mean.	L.S.D. P=0·05
	May.	June.	July.	August.		
Lygus simonyi	120·6	124·4	95·9	59·1	100	7·1
Green *Lygus* sp.	120·0	162·2	99·0	18·9	100	65·5
Lygus nymphs	107·6	103·4	141·8	47·1	100	52·7

LYGUS DAMAGE COUNT.

Date of Count.	Sowing-date.				Mean.	L.S.D.
	May.	June.	July.	August.		
8 weeks after sowing	91·1	119·0	126·4	63·6	100	6·8

The August sowing-date escaped the main influx of *Lygus,* possibly because it was not established before the neighbouring Sorghum was cut. In considering the sowing-date figures it should be remembered that the counts made on any two sowing-dates of the same age necessarily took place more than a month apart.

(*c*) *Spacing.*

LYGUS NYMPHS.

Date of Sample.	Spacing.			Mean.	L.S.D.
	3×½	3×1	3×1½		P=0·05
Weighted Mean of three three samples	117·4	96·0	86·6	100	17·3

LYGUS DAMAGE COUNT.

Date of Count.	Spacing.			Mean.	L.S.D.
	3×½	3×1	3×1½		P=0·05
8 weeks after sowing ..	102·4	100·5	95·2	100	4·2

This year there has been a tendency for the wider spacing to suffer less damage but it should be noted that the results of the previous season were

contradictory. Nevertheless there is strong evidence that varieties react differently to the various spacings.

(*d*) *Interaction Spacing* × *Variety.*

LYGUS SIMONYI. SAMPLES TAKEN 12 WEEKS AFTER SOWING.

Spacing.	Variety.						Mean.
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102	
3 × ½	110·0	102·2	127·6	93·1	74·2	80·7	
3 × 1	115·9	99·6	84·6	97·7	92·4	88·5	100
3 × 1½	116·5	104·8	89·2	116·5	105·5	100·9	

The difference in the behaviour of S.P.20 and S.P.93 is significant.

Jassids.

The counts of Jassid nymphs were made only on the 3 × 1½ ft. spacing of the Trial. Nymphs on five leaves per plant were counted and twenty plants in each plot were examined.

(*a*) *Varieties.* JASSID NYMPHS PER 50 LEAVES.

Date of Count.	Varieties.						L.S.D.
	S.G.29	M.2	S,P.20	S.P.84	S.P.93	S.P.102	P=0·05
16 weeks after sowing	9·0	7·9	8·5	10·2	12·5	5·2	2·0
20 weeks after sowing	19·6	31·0	20·4	26·6	40·8	11·1	6·5
Weighted Mean of two counts ..	14·3	19·5	14·4	18·4	26·6	8·2	3·8

Here again S.P.102 is the outstanding variety.

(*b*) *Sowing-dates.* JASSID NYMPHS.

	Sowing-date.				Mean.	L.S.D.
	May.	June.	July.	August.		P=0·05
Weighted Mean of two counts ..	43·4	63·5	123·7	169·4	100	53·6

Interaction Variety × *Sowing-date.*

JASSID NYMPHS PER 50 LEAVES. (BASED ON COUNTS MADE 16 AND 20 WEEKS AFTER SOWING).

Sowing-date.	Variety.					
	S.G.29	M.2	S.P.20	S.P.84	S.P.93	S.P.102
May	6·1	9·1	7·1	5·7	11·9	4·0
June	11·3	10·9	9·2	8·3	19·8	4·9
July	15·4	24·6	14·1	26·1	34·7	10·6
August	24·3	33·3	27·4	33·6	40·1	13·2

The interaction is significant. The behaviour of S.P.84 is interesting: in the May and June sowings only S.P. 102 showed greater resistance while in the July and August sowings only S.P.93 is more susceptible. In the 1937–38 season S.P.84 also had an abnormally high population on plants of the July sowing-date when compared with those of its June sowing but the interaction Sowing-date × Variety was not significant. It is worth noting here that A. M. Gwynn concluded that a population below 12 nymphs per 50 leaves had a negligible effect on yield.

P. R. STEPHENSON,
Entomologist.

REPORT OF THE SENIOR PLANT PATHOLOGIST.

On my journey home I visited the Sugar Experiment Station at Mt. Edgecombe, Natal, and consulted with the staff there on matters of mutual interest. We have arranged to interchange varieties of sugar-cane likely to be of value in our respective countries.

I spent three months of my home leave at the Imperial Mycological Institute and Kew Herbarium, attempting to bring the determinations of Uganda Fungi up to date. Much progress was made in this work, though a considerable number of collections still remain undetermined. A series of papers is in course of preparation dealing with the results so far obtained.

Wilt Diseases.

Verticillium Wilt.

During the past two years a large number of isolations of *Verticillium dahliae* have been made from a wide range of host plants. A selected number of these strains were used for pot inoculations on cotton (B.P.50), *Crotalaria juncea* and *C. striata;* the inoculations were made into the soil of the pots, which had been sterilised previously, before sowing the seed. Infections with almost all strains of the fungus were obtained on B.P.52 cotton, which is known to be susceptible to *Verticillium* wilt under field conditions at Bukalasa. It is considered that the few plants remaining wilt-free at the close of the experiments were the result of escape from contact with the fungus rather than inherent resistance of the individual plants. Few infections were obtained with the two species of *Crotalaria* and it is probable that a considerable proportion of the Uganda stocks of these plants are resistant to *Verticillium* attack.

No constant morphological or biological differences between the strains of *Verticillium dahliae* in this laboratory have been demonstrated, and the results so far obtained support those of workers elsewhere, that this fungus has a wide range of host plants. In the case of B.P.50 cotton the the incubation period of the disease varies from about six weeks to late in the development of the plants.

Fusarium Wilt Diseases.

Cross inoculation work has been continued with *Fusaria of* section *Elegans* isolated from a wide range of hosts. Hitherto the test hosts used in this work have been cotton (B.P.50), *Crotalaria juncea, C. striata,* and, on a smaller scale, *Sesamum indicum.*

Repeated trials have shown that the host range of some of the *Fusaria* used is wider than has been commonly accepted in the past. The *Fusarium* isolated from natural infections of *Crotalaria juncea* is able to attack some plants of *C. striata,* though other individual plants are resistant; while the fungus isolated from natural infections of *C. striata* is able to attack *C. juncea.* Positive results on *C. juncea* have also been obtained by inoculation with *Fusaria* from natural infections of cotton, *Sesamum indicum* and *Capsicum frutescens.* In the case of the test host B.P.50 cotton, infections were obtained in a few instances with *Fusaria* from widely

different hosts, including those mentioned above; all strains of *Fusarium* used in this work originated from the Government Plantation, Kampala. In the case of inoculation on cotton the organisms were isolated from all artificial infections and re-tested on B.P.50, again giving occasional infections. This variety of cotton appears to contain a fair proportion of plants resistant to *Fusarium* attack, as in no series of inoculations did 50% infection occur: positive results, irrespective of the strain of *Fusarium* used, were usually limited to about one quarter of the test plants.

The evidence so far obtained indicates that at Kampala the individual strains of *Fusarium* are capable of attacking a number of host plants, although in each crop only certain individual plants are susceptible.

Root Disease of Sim-sim.

At Kampala Plantation in 1937 a fairly severe attack of *Rhizoctonia bataticola* occurred in this crop. The fungus was isolated in culture and a series of inoculation tests carried out in pots of sterilised soil in which agar cultures of the fungus had been placed. No infection resulted, even in cases where the fine roots of the sim-sim were traced growing through the agar masses and in very close contact with the fungus. Tests were also carried out in flasks of sterilised soil inoculated with *Rhizoctonia* 3 weeks before sowing the seed: no infection resulted.

The only conclusion from these trials is that infection in the field depends on factors external to the host and fungus, and that the latter is at most a very weak parasite of *Sesamum*. Infection by *Oidium* sp. on the leaves did not render the plants more susceptible to *Rhizoctonia* under the conditions of the inoculation experiments mentioned above.

Sugar.

A number of new varieties were received from the Amani Quarantine Station during the period under review. These were grown at Kampala for observation and propagation and are now being released to the Uganda Sugar Estates.

A second consignment received in October, 1938, consisting of a number of Barbados hybrid seedlings, was planted at Kawanda during my absence. In order to obtain information on their reaction to Mosaic they were interplanted with rows of infected cane supplied from Lugazi Estate. Unfortunately owing to an exceptionally dry season all these canes are very backward and we now await rain to allow us to divide up the roots and propagate them on a better site. When this is being done they will be examined for signs of Mosaic Disease.

Publications.

(1) Annual Report of Plant Pathologist, 1937.

(2) Contributions towards the Fungus Flora of Uganda—II Meliolineae, Supplement: in Journ. Linn. Soc. London, vol. 51.

C. G. HANSFORD,
Senior Plant Pathologist.

REPORT OF THE CHEMICAL SECTION.

The Senior Chemist attended the conference on cotton growing problems called by the Empire Cotton Growing Corporation. He also visited Rothamsted to discuss the technique of soil structure measurement with Dr. E. W. Russell, and East Malling to study the plant injection methods of Dr. Roach.

The Chemist carried out the duties of Analyst to the Medical Department until the end of January, 1939, during which time Dr. (Mrs.) M. Griffith carried on the analytical and supervisory work of the section.

Dr. G. Griffith left the country on long leave prior to transfer to Malaya on April 21st, 1939.

In September, 1938, the Section was moved from Kampala to the new laboratories at Kawanda. As a result of the disorganisation entailed by the move very little detailed analytical work has been carried out and most of the advisory work has been based on the results obtained by the field test outfit.

Erosion and Regeneration.

The erosion and fertility experiments at Serere have been continued but the yield records suffered owing to the depredations of locusts. *Both Locusta migratoria migratorioides* and *Nomadacris septemfasciata* visited the station damaging the grain and cotton plots respectively. The groundnut plot on the erosion experiment was also damaged by wild pig. The erosion experiment is now under *Cajanus indicus* cover crop. Cycle IV of the fertility experiment was opened in April and prepared for cotton.

Grass plots at Serere and Kampala have been under observation and soil samples have been taken for structure analysis from under various local and imported grass covers. Examination of the soil profiles shows clearly that *Paspalum notatum, Cynodon plectostachyum, Panicum maximum* and *Brachiaria brizantha* are efficient covers from the point of view of crumb formation but it is not yet known whether the methods of structure analysis so far evolved will be sufficiently fine to show up the differences in efficiency of various grass covers. Elephant grass (*Pennisetum purpureum*) is, as far as we can judge, the most efficient soil regenerator of all the grasses yet tried.

Manuring.

Whilst efforts are being continued to popularise the manufacture and application of farmyard manure in all cattle districts, advantage was taken of an offer of the Cotton Association to rot cotton seed in pits for distribution to Africans in the neighbourhood of the ginneries. Many ginners co-operated wholeheartedly and several hundred tons of rotted seed were made available for distribution. The greatest difficulty was experienced, however, in persuading the natives to apply the manure even when it was taken to the neighbourhood of the plots by lorry. They were advised to apply it to one half of each plot so that they might see for themselves the result. Plots so treated showed that the manure had a beneficial effect

but, even so, there were hundreds of tons of material still available for distribution at the end of the year.

The cotton seed—cotton seed meal experiments were continued and up to date no significant results have been obtained. The experiments are being repeated with the heavier dressings and the results from the whole series will be summarised.

It has been noted that when cotton seed is rotted in pits or stacks there is a heavy loss of nitrogen as ammonia. Dr. Griffith in collaboration with Mr. Chandler carried out a series of composting trials mixing the cotton seed with varying amounts of dried leaves of low nitrogen status. The results have been summarised for publication elsewhere* and need not be repeated here but it was found that there was a loss of nitrogen of over 17% when the proportion of leaves to seed was in the region of two to one so that a much greater dilution with material of low nitrogen status is indicated if loss is to be reduced to a minimum.

Soil Survey.

Mr. G. Milne, the Soil Chemist of Amani was on tour in Uganda from the end of January until April 10th. His visit was organised to examine the major soil types and to co-ordinate our work on soil survey with that in progress in the other Territories served by the East African Agricultural Research Station. The ultimate idea is to bring the Soil map of East Africa up-to-date. Mr. Milne was able to traverse most of the Protectorate except Karamoja and the higher parts of Elgon. On his journeys through Buganda, the Western Province and the Northern Province, he was accompanied by Dr. Griffith and the Agricultural Officers concerned. In the Eastern Province the Senior Chemist was able to accompany the party.

W. S. MARTIN,
Senior Chemist.

*Griffith and Chandler. The Conservation of the Nitrogen of Cotton Seed. *East African Agricultural Journal* (In the press).

REPORTS OF THE BOTANICAL SECTION.

(i) REPORT OF THE SENIOR BOTANIST.

Introduction.

The Senior Botanist proceeded on leave in May, 1938. Mr. Jameson took over the work at Bukalasa and the greater part of this report was drafted by, and represents work conducted by him. At the close of the season the breeding work was transferred from Bukalasa to Kawanda. The special wilt infected plots at Bukalasa are being retained until similar plots are available at Kawanda.

Meteorological—Bukalasa.

The 1938–39 cotton season was later than the previous one, but was not abnormally bad in relation to earlier years. Bukalasa and neighbourhood were more fortunate than the country as a whole, and the cotton crop on the plantation was at least as good as in the previous season. A general change over from 4 ft. × 1½ ft. to 3 ft. × 1 ft. spacing contributed to this result.

Rains were good till the end of June, but failed in July for fully three weeks. Most of the cotton was planted in very good time and was well enough established to survive until rains fell again at the end of July. The later cotton gained a final impetus when rain fell in December, but grade was damaged to a considerable extent by abnormal rains in February.

No serious hail damage occurred.

TABLE I.—RAINFALL AT BUKALASA.

Month.	Total Rainfall (ins.)	Mean 1921—1937.	Highest Fall (ins.)	Number of Days on which rain fell.
1938.				
January	0·41	1·44	0·26	4
February	1·55	2·63	1·15	4
March	4·20	4·90	1·17	14
April	5·40	6·80	1·15	20
May	5·11	5·29	1·12	23
June	4·46	3·52	1·28	12
July	1·05	3·23	0·30	10
August	2·85	4·65	0·56	15
September	5·90	5·07	2·03	17
October	7·06	6·68	2·00	22
November	3·36	4·28	0·72	12
December	2·91	3·54	1·04	10
	44·26	52·02	2·03	163
1939.				
January	1·86	1·44	0·87	7
February	5·82	2·63	1·94	13
March	4·39	4·90	1·49	11

Cotton.

Breeding Plot.

New Selection Series.—This series was disappointing. New selections from the local crop were not numerous or particularly promising. Nine U.4 strains received from Gatooma were very stunted in growth, and six U.4 strains received from Barberton were badly damaged by wilt. A reference plot of local and imported types was maintained as usual.

Pedigree Line Series.—This series comprised derivatives of B.P.52, which has now reached the first stage of increase in native cultivation; of B.P.50, which was set aside in 1936, on account of susceptibility to wilt; of B.181, which is a vigorous but rather short-stapled local strain; and of S.P.102, a Nyasaland Upland (probably hybrid) strain from Serere. Work on B.P.52 derivatives is being concentrated on obtaining high resistance to Blackarm; on the B.P.50 group it is aiming at wilt resistance; and in the B.181 group at a longer staple. No really satisfactory improvements were obtained except for two lines of B.181 which appeared to have a longer staple than the original parent. B.181 is a very valuable variety as it is highly resistant to Blackarm and also to wilt; its lint characters are, however, poor and it is hoped to improve these by further selection, and by hybridisation with B.P.52. One of the B.P.50 group (B.P.220) selected at Serere showed distinct promise, being resistant to Blackarm and apparently to wilt. The following table summarizes the characters of some of the leading strains:—

TABLE II.

Group and Origin.	Pedigree.	Ginning Percentage.	Lint Length (mm.)	Blackarm mean. Lesions per plant.	% plants attacked by wilt.	
					External %	Internal %
B.181.. ..	B.P.206 ..	30·9	29·6	0·92	2	20
	B.P.208 ..	32·1	29·5	Nil	8	44
Local ..	B.P.209 ..	32·5	29·5	0·04	8	38
	B.P.210 ..	33·5	28·2	Nil	4	8
	B.P.213 ..	32·1	29·8	0·79	2	16
B.P.50 ..	B.P.217* ..	31·2	31·2	1·44	32	0
Local ..	B.P.220 ..	31·9	31·9	0·02	2	2
S.P.102 ..	S.P.102 B.1 ..	33·8	30·0	0·00	6	30
S.G.29 hybrid	S.P.102 B.2 ..	33·4	29·8	0·22	10	20

*B.P.217 was rogued for wilt after the first count.

Mass Selections.—The existing mass selections from Local gave such disappointing results (*see* under "Variety Trials") that it was decided to make a new selection from Local on a somewhat broader basis. A small plot containing a population of about 300 was found convenient for the purpose. All plants showing symptoms of Blackarm in December (the incidence of the disease was not heavy this year) were rigorously excluded from selection. The plants were left unharvested, and in February twelve were selected by eye for habit and general appearance. Each was uprooted and broken as a check on wilt. The cotton was collected and examined

in the laboratory for lint length and ginning percentage. The results are of great interest:—

TABLE III.

No.	Approximate Yield (g)	Boll Weight (g)	Ginning %	Lint Length (mm.)	Lint Character.	Seed Type.
14	172	4·9	32·6	27·8	harsh	full fuzzy.
19	173	4·9	31·6	27·9	harsh	light fuzzy.
79	129	5·1	29·7	30·2	silky	fuzzy.
96	153	4·9	37·7	28·3	silky	semi-naked.
101	112	5·6	34·2	29·2	full	full fuzzy.
125	134	5·1	31·7	27·8	fair	full fuzzy.
171	66	3·8	33·3	28·2	fair	green fuzzy.
186	125	4·3	31·4	28·9	silky, full	fuzzy.
286	73	5·0	37·0	27·4	harsh	fuzzy.
350	252	5·9	34·8	25·3	fair	semi-naked.
395	48	4·6	29·1	29·0	fair	fuzzy.
465	101	5·8	34·8	28·4	full, even	full fuzzy.
Mean ..	..	5·0	33·2	28·2	..	..
Mean of Local ..	..	4·8	29·9	27·5	silky	very mixed.

It will be noticed that selection by eye for plant type has maintained lint length and given a quite remarkable increase in ginning percentage. Nos. 101 and 465, which fall very nicely into the outer quadrant of the ginning percentage—lint length target, have been set aside for the new selection series. One or two others may also be tried in this series, as a population of twelve or less is hardly sufficient for a mass selection. Two good selections out of 300 indicate that good material is somewhat rare. Five selections out of the twelve had mauve hairy stems, and Nos. 101 and 465 both come under this class.

Increase Plots.

Main Increase—12 Acres.—B.P.52 gave a yield of 909 lbs. per acre, the May and June sown areas yielding at about the same rate. The incidence of Blackarm was much lower than in the previous season. The crop was ginned commercially and gave a ginning out-turn of 30·8%.

Middle Increase—1¼ Acres.—A mixture of S.G.23/8, B.P.52 and B.P.79 gave a yield of 1,300 lbs. per acre, which, on a mediocre plot, was quite a remarkable performance. The ginning out-turn was 32·4%.

Small Increase—¼ Acre.—B.347 II, a selection out of B.P.50 for freedom from wilt, gave a yield of 882 lbs. per acre. The plot was almost free from wilt, but this of course does not prove a negative. The ginning out-turn was 32·3%.

Supplementary Increase—1 Acre.—B.181, planted at the beginning of August, gave a yield on good soil of 979 lbs. per acre. Considering the late sowing date this was probably the best performance of all. This was ginned commercially and gave a percentage of 31·7%.

Kawanda Seed Farm and Segregated Area.

This stage of increase was used for the first time and the variety B.P.52 was distributed throughout the area. Very careful precautions were taken to ensure that all cotton from the previous season and all volunteer plants were uprooted before any planting was done. The distribution of seed worked smoothly and when the cotton was ginned there was no sign that any mixing had occurred; a very satisfactory state of affairs for a first season's working. The total area planted was 156 acres, less than half that of the previous season. The area actually harvested was only 141 acres, the remaining 15 acres having been abandoned from various causes. The poll tax paying population was 113 so that the area harvested per taxpayer was only 1·25 acres. All plots were measured; the spacing of each plot was estimated; and during the buying season the amount of cotton sold by each tenant was recorded; so that a complete picture of the cotton crop of each tenant is available.

The spacing averaged 3·9 ft. between rows and 3·1 ft. between plants, with an average of 1·8 plants per hole. This was disappointing, as it was even worse than the average spacing for the whole of Mengo. Nearly 50% of the crop was interplanted with beans and/or groundnuts.

The crop purchases were as follows:—

	Safi (lbs.) (1st quality).	Fifi (lbs.) (stained).	Lbs. Total.	Yield per Acre lbs.	Acreage.
Seed Farm ..	42,356	2,620	44,976	591	76
Segregated Area ..	36,677	1,504	38,181	589	65
TOTAL ..	79,033	4,124	83,157	590	141

The quantity actually ginned was 84,439 lbs., the excess of 1,282 lbs. being largely the difference between the true weight of gunny bags and other containers and the legal tare of 3 lbs. which is deducted. The true yield over the whole area, therefore, was 598 lbs. per acre—a very satisfactory result.

The total sum of money paid to growers was Shs. 6,551/50 equivalent to Shs. 58 per taxpayer and Shs. 47 per acre.

Yields varied considerably from plot to plot the range being from 96 lbs. per acre to 1,650 lbs.

The crop was ginned at Kawempe and gave a ginning percentage of 31·47%.

Much of the land under cultivation on the Seed Farm is on steep slopes and in the past erosion has been severe. A soil conservation programme is being carried on and over six miles of contour bunds have already been constructed. In a few cases cultivators have constructed bunds on their own initiative and it is very encouraging to report that practically the whole of the 1939 spring sweet potato crop has been planted on ridges across the slope. The rainfall recorded at Kawanda for the period

January, 1938 to March, 1939, was as follows:—

TABLE V.

	Rainfall in inches.	Number of days.
1938.		
January	0·29	5
February	0·35	1
March	4·02	12
April	6·64	13
May	3·66	9
June	2·81	8
July	1·12	4
August	1·49	7
September	3·56	11
October	7·35	13
November	1·94	8
December	3·34	15
Total for 1938	36·57	106
1939.		
January	1·68	7
February	5·38	16
March	2·07	10
Total April, 1938—March, 1939 ..	41·04	121

Variety Trials.

The *main variety trial,* an 8 × 8 Latin Square, was planted at the beginning of July and started badly in the July drought. It was not possible to supply until August and the final stand was very uneven. Yields were to some extent proportional to stand, but correction does not make any very material difference to the results.

TABLE VI.

Variety.	Stand % *	Total Blackarm Lesions per Plant. (Dec.)	Wilt. External. †	Wilt. Internal. ‡
Local	49·5	0·82	7·0	19·6
B.181 (*ex* Local)	60·3	0·64	1·3	11·3
B.P.52 (*ex* Nyasaland Upland and N.3/5)	48·3	1·72	5·6	18·2
B.P.116 V (*ex* B.P.52)	62·5	2·80	15·4	28·1
B.P.104 (*ex* Nyasaland Upland and S.G.23/8)	65·9	0·97	4·1	13·6
Mixture (S.G.23/8, B.P.52, B.P.79) ..	57·9	0·95	9·8	17·2
S.P.84 (*ex* U.4/4/2)	49·3	0·36	11·5	20·0
S.P.102 (*ex* Nyasaland Upland and S.G.29 hybrid)	49·3	0·35	4·0	19·7
Significant Difference	6·2	0·56	8·0	none

*3 ft. × 1 ft. spacing, possible two plants per hole.

†External symptoms in January (% of stand).

‡Internal symptoms on uprooting in March (% of stand).

TABLE VII.

Variety.	Total Seed Cotton (lbs. per acre).	Ginning %*	Lint (lbs. per acre)†	Lint Length mm.
Local	1,395	29·4	411	26·6
B.181	1,895	32·5	617	28·6
B.P.52	1,565	31·0	484	31·3
B.P.116 V	1,834	30·5	560	31·7
B.P.104	1,841	30·1	554	28·7
Mixture	1,716	31·9	549	30·2
S.P.84	1,584	34·9	554	28·4
S.P.102	1,369	32·4	444	29·1
Significant Difference ..	163	0·5	56	..

*One sample ginned from each plot.

†Total Seed Cotton × Ginning % plot by plot.

This trial is discussed further under the heading of wilt.

Local and S.P.102 have given the poorest yields and in addition Local has the lowest ginning percentage and shortest staple. B.181 has given a very satisfactory yield, has a high ginning percentage and is resistant to Blackarm and Wilt; its staple is short and rough and in its present state it would not be suitable to replace Local. B.P.52 still remains the best variety for replacing Local as its lint quality is definitely superior.

With regard to Wilt, the analysis of external symptoms shows B.181 to have significantly less wilt than B.P.116, S.P.84 and the Mixture; and all varieties to have less than B.P.116. Mass selections were tested in a small separate trial and the results are tabulated below:—

TABLE VIII.

	Total Seed Cotton (lbs. per acre).	Ginning %*	Lint (lbs. per acre)†	Lint Length (mm.)
Local	1,472	29·9	440	27·5
Mass 1	1,115	29·6	330	27·7
Mass 2	1,247	28·5	355	29·2
Mass A	1,349	29·2	393	28·1
Significant Difference ..	106	0·5	31	0·8

*Two samples ginned from each plot.

†Total Seed Cotton × Ginning % plot by plot.

The correlation between Ginning % and Lint Length is —0·9978 which is significant at 1,000: 1.

Seed Type.—The trend of selection led towards white and green fuzzy and away from naked; also towards a heavier and fuzzier seed.

District Variety Trials.

The usual series of 4 × 4 Latin Squares was extended to ten centres in Buganda. These trials were considerably more successful than they have been in the past, the error variance per plot being only 13·3% as against 15·8% in the previous season. This is attributed to a general settling down and improvement of the land reserved for these trials. For the first time 3 ft. × 1 ft. spacing was adopted, with the result that the average yield was much higher, although the yield from the native crop in Buganda was lower than in the previous season.

TABLE IX.—TOTAL SEED COTTON, LBS. PER ACRE.

Centre.	Planted.	Local.	B.P.52.	S.P.102.	B.181.	Significant Difference.
Bukalasa	20 June	1,435	1,316	1,297	1,775	334
Bukalasa	13 Aug. ..	1,199	1,264	1,044	1,361	190
Kalagala	20 July ..	1,318	1,307	1,154	1,410	..
Nakifuma ..	4 July ..	1,548	1,469	1,428	1,600	..
Mukono	4 July ..	1,398	1,562	1,363	1,532	..
Bukomero	27 July ..	754	1,040	1,003	909	182
Kabasanda ..	27 July ..	1,257	1,208	986	1,342	125
Nkozi	27 June	1,979	2,017	1,958	2,047	..
Kalungu	30 May ..	1,169	803	663	873	309
Kyanamukaka ..	21 June	1,637	1,328	848	1,677	459
10 centres mean ..	—	1,369	1,331	1,174	1,453	79

The interaction of variety and centre is highly significant. It is evident that the Nyasaland Upland varieties (B.P.52 and S.P.102) do poorly in Masaka District (Kalungu and Kyanamukaka). On the other hand they do relatively well at Bukomero in the north-west of Mengo District. Over all the conclusions regarding the four varieties show that B.181 yields better than the others; there is no difference between Local and B.P.52 and all are better than S.P.102. The general level of yields is high and the very high yields at Nkozi are particularly noteworthy. The Blackarm records were as follows:—

TABLE X.—BLACKARM LESIONS PER PLANT: NOVEMBER.

	Local.	B.P.52.	S.P.102.	B.181.	Significant Difference.
Bukalasa (June)	0·33	1·58	0·12	0·26	0·53
Bukalasa (August)	0·46	1·79	0·46	0·63	0·73
Kalagala	1·67	3·36	1·44	2·94	1·38
Nakifuma	1·28	5·87	0·68	0·45	2·34
Mukono	1·00	2·31	0·25	0·95	1·06
Bukomero	1·56	2·40	1·30	1·49	..
Kabasanda	0·49	1·09	0·09	0·27	0·36
Nkozi	0·34	1·10	0·39	0·36	..
Kalungu	0·49	1·46	0·11	0·22	0·97
Kyanamukaka	0·78	1·81	0·18	0·19	0·38
10 centres	0·84	2·27	0·50	0·77	0·29

The conclusions from these figures are self-evident.

TABLE XI.—LINT IN LBS. PER ACRE.

Centre.	Local.	B.P.52.	B.181.	S.P.102.
Bukalasa (June)	406	400	555	414
Bukalasa (August)	338	384	426	436
Kalagala	379	406	440	370
Nakifuma	451	454	525	456
Mukono	429	501	504	436
Bukomero	259	325	264	322
Kabasanda	376	386	437	290
Nkozi	570	625	654	626
Kalungu	346	257	292	212
Kyanamukaka	505	421	540	271
Means	405·9	415·9	463·7	383·3
Mean Ginning Outturn	29·5	31·3	32·3	32·0

Two sowing dates were used at Bukalasa to find out if quick maturing strains showed up to greater advantage at later sowings. This proved to be the case—Local, which is late maturing, showed a reduction of 17% in yield, B.181 also late maturing showed a reduction of 23% whereas B.P.52 a quick maturing strain only showed a reduction of 4%. This would be of distinct value in Buganda where so much cotton is planted late.

The lint yields follow much the same order as seed cotton except that B.P.52 comes above Local; and the difference between S.P.102 and Local so marked in the case of seed cotton is only slight in the case of lint.

Spinning Tests and Brokers' Reports.

Through the courtesy of the Empire Cotton Growing Corporation, the Shirley Institute and the Indian Central Cotton Committee the usual series of lint samples was tested. B.P.52 was again outstandingly superior to Local except for neppiness, a defect which appears to be inherent in the strain.

The Shirley Institute reports may be summarised as follows:—

Place grown.	Variety.	Count × Strength at 50's.	Highest standard count.	Valuation (January American 4·97).
Bukalasa ..	Local ..	1,962	48	5·72d.
Bukalasa ..	S.P.102 ..	1,846	41	..
Bukalasa ..	B.P.52 ..	2,351	74	6·37d.
Bukalasa ..	S.P.84 ..	2,020	51	..
Bukalasa ..	Mixture (S.G.23/8, B.P.52 and B.P.79) ..	2,185	62	..
Bukalasa ..	B.181 ..	2,065	54	5·57d.
Bukalasa ..	B.P.104 ..	2,140	60	..
Mukono ..	B.P.52 ..	2,300	71	6·72d.
Mukono ..	Local ..	1,903	46	6·22d.
Bukomero ..	B.P.52 ..	2,328	70	5·47d.
Bukomero ..	Local ..	1,844	43	5·72d.

Reports on some of the bales of B.P.52 cotton grown on the Kawanda Seed Farm have already come in and comment favourably on the performance of B.P.52 compared with ordinary Local Buganda.

Reports from the Indian Central Cotton Committee's Technological Laboratory showed that B.P.52 gave better spinning performance than the respective Local cottons among which the Bukalasa sample yielded stronger yarns than the Kabasanda sample. A summary of the results is tabulated below:—

Variety.	Count × Strength.			Highest Standard Warp counts.
	30's.	40's.	50's.	
B.P.52, (Bukalasa) ..	2,356	1,983	1,773	53
Local „	2,027	1,779	1,636	48
B.P.52 (Kabasanda) ..	2,269	1,998	1,822	53
Local „	1,845	1,723	1,609	46

Cotton Cultivation Experiment.

This repeated an experiment made in the previous year, but was laid down on an improved plan designed with help from Rothamsted. The results of both experiments are tabulated here and afford an interesting example of modern improvements in experimental design.

TABLE XII.—TOTAL SEED COTTON: LBS. PER ACRE.

	1937/38 Experiment (fair new land). B.P.52 Seed.	1938/39 Experiment (good new land). Local Seed.
Total plots	144	108
Error of variance of a single plot	12·3%	8·2%
May sowing	1,037	..
June sowing	991	1,717
July sowing	..	1,296
August sowing	601	853
Significant difference	not replicated.	50
4½ ft. × 2 ft. spacing	..	1,195
4 ft. × 1½ ft. spacing	768	1,287
3 ft. × 1 ft. spacing	985	1,385
Significant difference	36	50
1 plant per hole	844	1,217
2 plants per hole	909	1,309
3 plants per hole	..	1,341
Significant difference	36	50
Control	927	1,314
Interplanted with beans	826	1,264
Significant difference	36	41

In the 1938–39 Experiment there are no significant differential responses. In the 1937–38 significant differential responses were found in the following two-way tables:—

TABLE XIII.—SPACING × SOWING DATE.

	May.	June.	August.
4 ft. × 1½ ft.	946	846	512
3 ft. × 1 ft.	1,128	1,136	690

TABLE XIV.—PLANTS PER HOLE × INTERPLANTING.

	Control.	Interplanting.
1 plant per hole	877	812
2 plants per hole	977	840

In the later experiment good land has caused a general levelling up thereby eliminating interactions between pairs of factors. In this experiment all pairs of factors at three levels were partially confounded (F. Yates, Imperial Bureau of Soil Science, Technical Communication No. 35, paragraph 13 g.). It will be noticed that error variance was reduced although the plots were fewer and the treatments more numerous.

This experiment is referred to again under the heading of Wilt.

Wilt Diseases.

Although *Verticillium dahliae* and different species of *Fusarium* are known to attack cotton at Bukalasa no attempt is made in this report to distinguish between them. Bukalasa lacks equipment for this kind of work and the Senior Plant Pathologist has been on leave.

Symptoms.—The external wilting symptoms were recorded during or immediately after the grand period of growth, and extensive uprooting was

done at the end of the season to record the presence of brown streaks in the xylem tissues of the main stem. Both records were given in the main variety trial, and although the count of external symptoms gave a significant result the count of internal symptoms did not. External symptoms are probably the result of intense host reaction and are less common than the internal symptoms.

Programme.—It was decided to make counts on all replicated experiments where wilt was at all prevalent in the hope of learning something about the relation of wilt to general cotton agronomy.

Cotton Cultivation Experiment.—This experiment was carried out on good land freshly cleared from Elephant Grass.

Table XV.—Percentage of Plants with Internal Symptoms of Wilt.

Sowing Date.	%	Spacing.	%	Plants per Hole.	%	Interplanting.	%
June ..	17·4	4½ ft. × 2 ft.	16·6	One	15·2	Control	15·8
July ..	9·6	4 ft. × 1½ ft.	13·0	Two	11·7	Interplanted	9·2
August ..	10·6	3 ft. × 1 ft.	8·1	Three	10·7	—	..
Sig. Diff. ..	6·6	—	6·6	—	none	—	5·4

The sowing date records have little interest, as early sown cotton has much the better yield in spite of wilt. The spacing records are confirmed by those from plants per hole although these in themselves are not significant. The interplanting records are of great interest in a country where interplanting is a widespread practice. Wilt appears to be kept down by shading and reduction of exposure, and it is probable that the factor at work is soil temperature.

Main Variety Trial.—This trial occupied a field which was being used for the second successive year. It has already been seen that only the external symptoms revealed significant differences between varieties. There were no spacing treatments in this experiment, but owing to the irregular germination there were considerable differences in stand. Residual correlation in covariance shows that differences in stand had an effect on wilt similar to the larger effects brought about by actual spacing treatments. The residual correlation between yield and total wilt is highly significant, both in this experiment and the previous one, showing that wilt was responsible for over-all losses of from 3% to 6%. Furthermore a reduction in ginning percentage equivalent at 0·34% was shown to have occurred in the main variety trial; this was confirmed by further observations in the Mass selected variety trial.

Wilt and Variety.

In the matter of varietal susceptibility the results from the main variety trial do not present a very strong case. In the breeding plot, however, each of the three chief families, B.P.50, B.P.52, B.181, was represented by a number of lines and these were planted alternately with lines of Local. Plants showing external symptoms of wilt were counted in October, but owing to subsequent roguing no comprehensive count of plants showing internal symptoms on uprooting was achieved. Using the number of plants showing external symptoms the following regressions are found.

TABLE XVI.

Regression.	Number of Lines.	Regression Coefficient.	S.E. of regression coefficient.
B.P. on Local	12	2·191	0·291
B.P.52 on Local	5	1·116	0·335
B.181 on Local	9	0·127	0·056

The conclusions are plain. B.P.50 is more susceptible than Local, B.P.52 or B.181 (more than two wilted plants for every one of Local). B.P.52 is similar to Local. B.181 is less susceptible than Local, B.P.52 or B.P.50 (about one wilted plant for every eight of Local).

Soy Beans.

Small increase plots of imported types, restricted to yellow beans only, were planted in both seasons for observation.

A variety trial was also planted in each season to test the more promising types chosen from previous increase plots. The same land is being used for successive crops and, although no successful observations of nodule formation have been made, there was a marked improvement in the appearance of the last crop which would be consistent with a process of self-inoculation.

TABLE XVII.—YIELD OF SHELLED BEANS: LBS. PER ACRE.

Variety.	Country of Origin.	March sown crop.	September sown crop.
Local	Venezuela ..	922	958
Barberton Y 1	South Africa ..	536	550
Palmetto	U.S.A. ..	647	733
R 42	South Africa ..	819	937
R 51	South Africa ..	690	735
R184	South Africa ..	712	966
R304	South Africa ..	635	691
R 42 a	South Africa ..	851	..
Significant Difference ..		151	161

Improvement is most marked in the varieties R 184, R 181 and R 42. The second crop was damaged by locusts (*Locusta migratorioides*) in November and it was noteworthy that damage to the early maturing varieties, Barberton Y 1 and R 304, was most severe whilst the late maturing varieties, Local and R 184, were almost untouched.

Groundnuts.

A number of small increase plots were planted for observation.

Variety trials were planted in both seasons to test the Indian variety AK 10 against the Local Bunch type.

TABLE XIX.—YIELD OF SHELLED NUTS: LBS. PER ACRE.

	Local.	A K 10.	Level of Significance.
March sown crop	1,085	1,054	none
October sown crop ..	941	703	1,000:1
BOTH	1,013	879	20:1

In the second crop the yield of AK 10 in terms of unshelled nuts was lower than that of Local, and in addition the shelling percentage was very

low indeed. It should be added that Local matured in $3\frac{1}{2}$ months in each case, whilst AK 10 matured in $4\frac{1}{2}$ months in the first season and in 5 months in the second. AK 10, therefore, could have no place in the local native rotation where cotton follows groundnuts.

The incidence of rosette in the first trial was negligible. The second trial was planted to test the behaviour of AK 10 as rosette is normally more prevalent in the late season, but rosette was again negligible. The spacing was 1 ft. × 1 ft.

Observation plots of *Voandzeia* were also planted in the early season.

Sesame.

A number of rows were grown for selection and increase purposes. In addition six types were tested in a variety trial. Once again it must be recorded that Sesame is not often a successful crop at Bukalasa, and its sensitive reaction to patchy soil makes it a very difficult crop to test in formal trials.

TABLE XX.—YIELD OF THRESHED GRAIN: LBS. PER ACRE.

Variety.		Yield.
Local		133
Bwonyo (from Lango)		162
Nandigobe	Different types isolated from Local Buganda.	149
Zoya		148
Luzige		96
Nalongo		95
Significant Difference		none

Food Crops.

Observation plots of Bananas, Sweet-Potatoes, Peas, Beans, Cassava and Yams have been maintained. In an extensive series of Sweet-Potatoes there appears to be promise of isolating one or two strains of high yielding palatable types with white skins. No Cassava trials have become due for harvest this year.

Tobacco.

A series of imported types was planted as usual, but was entirely destroyed by leaf-curl. In fact tobacco failed all over the plantation from this cause.

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Senior Botanist.
J. D. JAMESON.
Agricultural Officer.

(ii) REPORT OF THE BOTANIST, SERERE.

Meteorology.

The total rainfall in 1938 was seven inches below average. The first rains were late in breaking, but May was abnormally wet and rain fell abundantly throughout the planting season. The second rains were normal, but the onset of the dry season was early and well marked. The native grain crop was delayed for want of rain with the result that native cotton planting in its turn was delayed. Cotton ripened rapidly in the dry season, however, and although yields were low some of the time lost was made up. At Serere the May and June cotton sowings yielded equally, yields from July and August sowings falling off in the usual way. May sown cotton might, as is normal, have given the highest yield, but it was damaged by hail in June.

Diseases and Pests.

Black Arm disease was rather more prevalent than in the previous season. This was surprising, as the 1938 rainfall was twelve inches below the 1937 rainfall.

Jassids were not so numerous as in the previous season.

Lygus took its usual toll, and on the seed farm at Serere the damage was particularly heavy.

Cotton.

(1) *Pedigree Lines.*—These were laid down in the form of a replicated progeny row trial.*

The trial was planted on June 22nd, under good conditions.

Biological Characters.

Strain.	Parent Strain.	Origin.	Black Arm Lesions per Plant.	Jassid Nymphs per 50 Leaves.	Earliness from Flowering Curve.
S.P.153 ..	S.P.140 ..	S.P.87 from U.4/4/2..	2·00	8·2	Medium.
S.P.154 ..	S.P.144 ..	— ..	2·18	3·7	Medium.
S.P.155 ..	S.P.147 ..	S.P.102 from S.G.29	0·83	1·7	Medium.
S.P.156 ..	S.P.148 ..	hybrid.	0·51	1·4	Medium.
S.P.157 ..	S.P.148 ..	— ..	0·78	2·0	Early.
S.P.158 ..	S.P.149 ..	— ..	1·04	1·3	Early.
S.P.159 ..	S.P.151 ..	Nariama strain from N.17 ..	1·53	5·3	Very late.
B.P.50.S9 ..	B.P.50.S6 ..	Reselection from	2·27	3·4	Late.
B.P.50.S10 ..	B.P.50.S6 ..	Bukalasa B.P.50.	2·10	2·6	Late.
B.P.50.S11 ..	B.P.50.S6 ..	— ..	2·46	2·3	Late.
Significant Difference			0·82	2·3	
S.G.29 guard rows			6·50	3·5	

*Hutchinson and Panse (1937); *Indian Journal of Agricultural Science*, Vol. VII, Part IV, p. 531.

BOLL CHARACTERS.

Strain.	Effective Flowers per Plant.	Seed Cotton corrected for Stand (gms.).	Seed Cotton per Flower (gms.).*	Ginning Percentage	Lint Length (mm).
S.P.153	38·5	1,680	0·95	36·6	29·4
S.P.154	48·2	2,006	0·93	35·5	29·5
S.P.155	41·1	1,992	1·08	32·2	31·0
S.P.156	34·8	1,425	0·90	32·8	29·3
S.P.157	45·8	2,111	1·02	33·4	29·1
S.P.158	36·0	1,726	1·05	30·2	31·0
S.P.159	36·9	1,667	1·00	32·6	27·6
B.P.50.S9	44·2	2,175	1·08	31·3	31·1
B.P.50.S10 ..	45·1	1,971	0·97	31·7	31·4
B.P.50.S11 ..	51·0	2,499	1·17	31·8	31·0
Significant Difference ..	not calc.	519	not calc.	1·1	1·0

*See Annual Report, 1937, Part II.

S.P.155 achieved the best all-round performance. B.P.50.S11 did very well except for contracting too much Black Arm. S.P.157 was rather too short in staple, but otherwise good. The lay-out was successful as a variety trial, but it does not lend itself to successful single-plant selection and appraisement by eye was particularly difficult.

(2) *Serere Hybrids.*—The programme described in previous reports was continued, and yielded a quantity of promising material and interesting data. It is felt, however, that the present records are too diffuse to attempt a coherent account at this stage.

A new series of hybrids was started designed to investigate the inheritance of early maturity and of resistance to pests and diseases. The parent plants were sown in January using the insect cage as a large pot culture; in this way it was possible to raise the F1 generation later in the same year.

(3) *Nyasaland Hybrids.*—Nineteen hybrid strains received from Nyasaland were grown for observation and acclimatization. No selection was exercised.

(4) *New Selections.*—These comprised:—

(*a*) 36 reselections from U.4/4/2.
(*b*) 112 reselections from Nyasaland Upland.
(*c*) 3 reselections from a mixed Cambodia population.
(*d*) 6 American strains commercially resistant to Fusarium Wilt.
(*e*) 2 Wild cottons.
(*f*) 6 U.4 strains from Barberton.
(*g*) 9 U.4 strains from Gatooma.
(*h*) 1 Meade strain from Sudan.

The Nyasaland Upland series contained a large proportion of material reselected from commercial N.17 bulk. As foreshadowed last year N.17 has yielded a number of very hairy reselections, and the type has been much improved when compared with the parent stock growing in bulk. It remains to be seen whether staple and spinning quality have been impaired, but first indications are that they may on the contrary have been improved also.

(5) *Variety, Spacing and Sowing Date Trial.*—The experiment was laid out on Block B of the Experiment Farm in the same type of lay-out used in previous seasons.

The treatments were:—

Sowing Dates ... Mid May.
Mid June.
Mid July.
Mid August.

Spacings ... 3 ft × ½ ft.
3 ft. × 1 ft.
3 ft. × 1½ ft.

Varieties ... S.G.29 (control).
N.17.M2 (mass selection).
S.P.20 (*ex* U.4/4/2).
S.P.84 (*ex* U.4/4/2).
S.P.93 (Nariama strain).
S.P.102 (*ex* S.G.29 hybrid).

Yield.

In the tables which follow all yields are expressed in pounds per acre.

Varieties (Irrespective of Spacings or Sowing Dates).

Varieties.	Total Seed Cotton.	Ginning Percentage.	Clean Lint.
S.G.29	349	30·7	71
N.17.M2	412	30·6	77
S.P.20	588	35·6	135
S.P.84	544	34·7	121
S.P.93	336	29·9	63
S.P.102	538	31·4	109
Significant Difference ..	31	0·2	8

Sowing Dates (Irrespective of Varieties or Spacings).

Sowing Dates.	Total Seed Cotton.	Ginning Percentage.	Clean Lint.
Mid May	582	32·0	122
Mid June	586	32·5	118
Mid July	403	31·9	85
Mid August	273	32·2	59
Significant Difference ..	57	none	16

Spacings (Irrespective of Varieties or Sowing Dates).

Spacings.	Total Seed Cotton.	Ginning Percentage.	Clean Lint.
3′ × ½′	446	32·3	91
3′ × 1′	476	32·1	98
3′ × 1½′	461	32·0	100
Significant Difference ..	none	0·2	none

Clean Lint: Interaction of Varieties and Sowing Dates.

	Mid May.	Mid June.	Mid July.	Mid August.
S.G.29 ..	88·2	87·3	62·7	44·9
N.17.M2 ..	105·4	94·2	60·1	48·0
S.P.20	157·3	166·8	127·9	88·6
S.P.84	159·9	144·8	111·5	67·8
S.P.93	78·6	73·9	58·3	42·8
S.P.102 ..	140·9	140·4	91·6	64·8

The whole trial averaged 461 lbs. of seed cotton per acre and 96 lbs. of clean lint per acre (last season 856 and 192 respectively).

Conclusions.—The two U.4 varieties lead in yield and ginning percentage. S.P.102 is a good third *at Serere,* a fact which is referred to again in connection with the district variety trials. N.17.M2 yields better than S.G.29 and is equal to it in ginning percentage. Unfortunately there is no direct comparision with N.17 bulk. It is fairly certain that N.17.M2 has a higher ginning percentage than N.17 bulk as the latter always gives a lower percentage than S.G.29. The Nariama strain fails in yield and ginning percentage *at Serere.*

The relation between ginning percentage and sowing date found last year is not repeated, but the relation between ginning percentage and spacing is a new result. The higher percentage at close spacing probably implies a lower staple quality, but no measurements were taken to confirm this.

It will be noticed in the last table that S.P.20 holds up better than the other varieties at the later sowing dates.

Vegetative Efficiency.

Vegetative efficiency is the weight of seed cotton (lbs.) produced by each pound of aerial vegetable matter. The latter is obtained by weighing the "uprooted" plants at the end of the season.

Varieties (Irrespective of Sowing Dates and Spacings).

Variety.	Vegetative Efficiency.
S.G.29	0·063
N.17.M2	0·056
S.P.20	0·095
S.P.84	0·080
S.P.93	0·060
S.P.102	0·088
Significant Difference ..	0·007

Yields were much lower than in the two previous seasons, hence efficiency was less also. The comparative inefficiency of the three Nyasaland Upland strains, S.G.29, N.17.M2 and S.P.93, is apparent.

Sowing Dates and Spacings (Irrespective of Varieties).

	May.	June.	July.	August.	Spacing Means (Sig. Diff. 0·007).
3′ × ½′	0·098	0·073	0·054	0·043	0·067
3′ × 1′	0·094	0·073	0·064	0·064	0·074
3′ × 1½′	0·118	0·069	0·069	0·068	0·081
Sowing Date Means (Sig. Diff. 0·019) ..	0·103	0·072	0·062	0·058	0·074

This season efficiency decreased with delay in sowing, and the anomalous result that efficiency increases with wider spacing was repeated. The interaction of spacing with sowing date was significant, because all spacings were equally efficient in the June sowing date. This result might have applied to the May sowing date also had not the stands been seriously depleted by hail damage.

Black Arm.

(*a*) *Total Lesions per Plant.*

Varieties and Sowing Dates (*Irrespective of Spacings*).

	May.	June.	July.	August.	Variety Means (Sig. Diff. 0·5).
S.G.29	8·3	7·8	7·5	3·3	6·7
N.17.M2	6·7	6·1	5·3	2·0	5·0
S.P.20	1·9	1·7	1·0	0·8	1·4
S.P.84	2·9	3·5	1·9	1·1	2·4
S.P.93	2·8	2·0	1·5	0·9	1·8
S.P.102	4·6	3·4	3·4	0·7	3·0
Sowing Date Means (Sig. Diff. 0·3) ..	4·5	4·1	3·4	1·5	3·4

The interaction of variety with sowing date is significant.

Varieties and Spacings (*Irrespective of Sowing Dates*).

	3′ × ½′	3′ × 1′	3′ × 1½′
S.G.29	6·3	7·5	6·5
N.17.M2	3·9	5·7	5·5
S.P.20	1·3	1·3	1·5
S.P.84 .. .	2·3	2·4	2·5
S.P.93	1·6	1·9	1·9
S.P.102	2·8	3·1	3·3
Spacing Means .. (No Sig. Diff.).	3·0	3·7	3·5

The interaction of variety with spacing is not significant.

(*b*) *Intensity* (Lesions per pound of vegetable matter).

Varieties and Sowing Dates (*Irrespective of Spacings*).

	May.	June.	July.	August.	Variety Means (Sig. Diff. 1·1).
S.G.29	14·2	14·4	19·3	9·8	14·4
N.17.M2	8·4	9·6	9·4	5·8	8·3
S.P.20	3·3	3·1	2·6	3·0	3·0
S.P.84	4·1	6·4	3·9	3·3	4·4
S.P.93	4·0	3·9	3·3	3·7	3·7
S.P.102	6·9	6·1	7·0	2·5	5·6
Sowing Date Means .. (No Sig. Diff.).	6·8	7·3	7·6	4·7	6·6

The interaction of variety with sowing date is significant.

Varieties and Spacings (*Irrespective of Sowing Dates*).

	3′ × ½′	3′ × 1′	3′ × 1½′
S.G.29	20·1	14·4	8·9
N.17.M2	10·8	8·4	5·7
S.P.20	4·5	2·3	2·3
S.P.84	6·6	3·7	3·0
S.P.93	5·6	3·1	2·6
S.P.102	7·5	5·3	4·1
Spacing Means .. (Sig. Diff. 1·1).	9·2	6·2	4·4

The interaction of variety with spacing is significant.

The figures are much higher than in previous seasons. This difference is not altogether a real one, but is due to new observers counting on a

different basis. This is unfortunate, but the figures are comparative between themselves. The use of the intensity figure is an advantage when comparing spacings as it eliminates differences due only to size of plant. The two figures place varieties and sowing dates, however, in practically the same order.

N.17.M2 clearly represents a substantial advance on S.G.29 for resistance to Black Arm. Again unfortunately there is no direct comparison with N.17 bulk, which is also known to be more resistant than S.G.29.

The most striking result is the collapse of S.P.102, which last year was the most resistant of all varieties. This result is quite inexplicable, though it must be remembered that the strain is of hybrid origin and may not yet have settled down.

The Nariama and U.4 strains are still in a different class, and it is satisfactory to note that this is true of S.P.84 where hardiness has to some extent been sacrificed for lint quality.

(6) *District Variety Trials.*—Latin Squares were laid down at the same fourteen centres East of the Nile, but the needs of Busoga District were served by a single series of 5 × 5 squares this year. In the tables which follow all yields are expressed in pounds per acre.

Total Seed Cotton.

	N.17.	SP.20.	SP.84.	SP.102.	B.181.	Significant Difference.
Busoga District.						
Bugaya	604	703	596	478	458	..
Bulopa	891	884	1,098	823	1,077	..
Vukula	1,092	1,171	1,184	1,172	1,208	..
Nawanzu	896	939	968	980	943	..
Four Centres	871	924	962	863	922	..
Acholi and Lango Districts.						
Kitgum	867	919	917	782	..	97
Ngetta	490	732	703	554	..	106
Aduku	966	1,067	1,044	943	..	..
Kaberamaido	812	992	955	756	..	168
Three Centres (excl. Kitgum)	756	930	901	751	..	144
	SG.29.	SP.20.	SP.84.	SP.102.		
Teso, Central and Budama Districts.						
Serere	554	795	819	884	..	162
Katakwi	556	648	652	591	..	..
Nyero	417	591	626	491	..	72
Bukedea	780	937	893	795	..	120
Kibale	790	871	933	775	..	110
Mulanda	1,220	1,248	1,447	1,294	..	..
Six Centres	720	849	895	805	..	62

The trial at Kitgum was disturbed by building operations, and the yield from plot No. 1 (S.P.84) had to be calculated as a missing plot. For this reason the trial is not included in the combined analysis. The fourteen trials averaged 851 lbs. per acre, against 1,291 in the previous year. Stained cotton again had no value, but the figures for First Quality Seed Cotton are not given separately as, like last year, they are very similar to those for Total Seed Cotton.

The salient results are:—

(i) S.G.29 was again beaten by all the new strains.

(ii) S.P.102 quite failed to retain its advantage over N.17 in Busoga, and it did no better than N.17 in Lango. It did better than S.G.29 only at Serere and Nyero.

(ii) S.P.84 was again at least as good as S.P.20.

The value of an extensive series of trials in the districts is most apparent from these results. The strain S.P.102 has always had an excellent record at Serere, where it originated. Last year it was given a first trial in Busoga and did well. This year it did not do outstandingly well in Busoga and it is apparent from the larger series of trials that Serere is the only place which really suits it. Without the evidence of these district variety trials a serious mistake might have been made.

A further example in this connection of purely local adaptation is the Nariama strain. This strain has never been outstanding at Serere, in fact (like S.P.93 this year) yields have generally been decidedly poor. But all the Nariama strains have done remarkably well in Usuku County (where Nariama is) whenever they have been tried. S.P.36 and S.P.71 did well at Katakwi in 1934–35, S.P.72 in 1935–36 (though S.P.72 did well at some other centres) and S.P.88 in 1936–37.

Ginning Percentage.

	N.17.	SP.20.	SP.84.	SP.102.	B.181.	Significant Difference.
Busoga District.						
Bugaya	30·4	35·0	35·0	32·2	33·4	0·6
Bulopa	30·4	35·6	34·5	31·1	32·3	0·9
Vukula	29·6	35·0	35·0	31·7	31·5	0·9
Nawanzu	29·8	35·2	33·8	31·5	31·8	1·0
Four Centres	30·1	35·2	34·6	31·6	32·3	0·4
Acholi and Lango Districts.						
Kitgum	31·5	36·0	35·5	32·5	..	*
Ngetta	30·0	35·0	34·9	32·1	..	0·7
Aduku	29·6	35·0	34·8	32·9	..	1·8
Kaberamaido	31·3	35·6	35·0	32·9	..	2·1
Three Centres (excl. Kitgum)	30·3	35·2	34·9	32·6	..	0·8

	SG.29.	SP.20.	SP.84.	SP.102.		
Teso, Central and Budama Districts.						
Serere	31·0	35·1	34·5	31·6	..	1·0
Katakwi	33·3	36·9	35·9	33·8	..	1·3
Nyero	33·0	36·1	35·0	32·1	..	0·8
Bukedea	33·3	37·4	35·8	33·9	..	2·1
Kibale	32·1	36·9	35·4	33·4	..	1·0
Mulanda	31·1	36·8	35·8	31·9	..	1·1
Six Centres	32·3	36·5	35·4	32·8	..	0·4

*Bulk samples, not replicated.

The ginning percentage of S.P.84 has been well maintained. It is disappointing to see S.P.102 dropping below 33%.

Black Arm: Lesions per Plant.

	N.17.	SP.20.	SP.84.	SP.102.	B.181.	Significant Difference.
Busoga District.						
Bugaya	2·10	1·04	0·92	1·42	1·41	0·47
Bulopa	4·06	1·97	2·99	3·13	3·50	1·10
Vukula	4·49	3·25	4·70	4·16	4·13	..
Nawanzu	3·20	2·23	2·34	2·72	2·33	..
Four Centres	3·46	2·12	2·74	2·86	2·84	0·44
Acholi and Lango Districts.						
Kitgum	2·22	0·90	1·37	1·61	..	0·76
Ngetta	3·61	1·42	2·14	4·53	..	1·31
Aduku	6·47	1·52	3·29	3·46	..	1·18
Kaberamaido	3·17	1·34	2·44	4·47	..	0·99
Four Centres	3·87	1·29	2·31	3·51	..	0·46

	SG.29.	SP.20.	SP.84.	SP.102.		
Teso, Central and Budama Districts.						
Serere	4·57	1·20	1·07	2·00	..	0·86
Katakwi	6·50	2·27	3·71	4·05	..	1·89
Nyero	7·20	1·42	2·19	4·34	..	0·67
Bukedea	4·20	1·37	1·51	3·86	..	1·58
Kibale	2·97	1·67	0·92	2·61	..	1·20
Mulanda	2·51	0·82	1·09	2·27	..	0·85
Six Centres	4·66	1·46	1·75	3·19	..	0·42

These figures are much higher than last year, for the same reason as was given for the big trial at Serere. S.P.20 and S.P.84 retain the same relation to the control varieties as last year, but the performance of S.P.102 is disappointing.

(7) *Seed Type in the Commerical Cotton Crop.*—Two opportunities occurred to assess the seed types in the commercial crop. The first was during the Cotton Crop Estimate Traverses (December, 1938), as in the previous season, and the second during a large scale ginning test in April.

	White Fuzzy %		Green Fuzzy %		Naked %	
N.17 areas.						
Busoga	65	**83***	2	**1***	33	**16***
Lango	88	**80**	2	**1**	10	**19**
East Acholi (Chua) ..	†	**86**	†	**1**	†	**13**
S.G. 29 areas.						
Budama and South Bugishu	68	**68**	3	**2**	29	**30**
Bugwere and North Bugishu	81	**78**	2	**2**	17	**20**
Teso	93	**92**	1	**1**	6	**7**
West Acholi (Gulu) ..	†	**95**	†	**0**	†	**5**

*The ginning test data are inserted in italics.

†Mean for all Acholi, 90%, 1%, 9%.

The impurity of Budama seed is again striking. The two samples agree very well except (i) that the later Lango sample is rather less pure (ii) that the later Busoga sample is very much purer, an unexpected and unexplained result, as the later samples in Buganda were emphatically less pure than the earlier ones.

It is unfortunate that the administrative districts are no longer co-terminous with the cotton zones to which the two varieties conform. These studies are interesting, however, and it is probable that much more might be learnt from them.

(8) *Cotton Seed Multiplication.—*

(*a*) *Quarter-acre Increase.*—The varieties grown were Reselected Buganda, N.17.M2, B.P.50.S6, S.P.93 and S.P.102. The yields were very high indeed except from B.P.50.S6 where the seed supply allowed only a scanty stand.

(*b*) *Three-acre Increase.*—S.P.84 was grown for observation and roguing, and over an area of 2½ acres net yielded 892 lbs. per acre.

(*c*) *40-acre Seed Farm.*—S.P.102 was grown for increase, on its reputation at Serere. It suffered somewhat severely from *Lygus* and the final yield was disappointing. Over 40 acres gross the yield was 530 lbs. per acre, but the net area was never accurately determined.

(*d*) *Mulondo Segregated Area.*—S.P.84 was returned to this area and 388 acres were planted. The yield was 510 lbs. per acre which was eminently satisfactory.

(*e*) *Labori–Kadunguru Area.*—Owing to the very low yield at Mulondo in the previous season the seed of S.P.84 would only suffice to plant Kadunguru. Here 2,868 acres were planted and yielded at the rate of 288 lbs. per acre. Labori was planted with S.G.29 and 1,219 acres yielded only 199 lbs. per acre.

(*f*) *Serere–Kasilo Area.*—S.G.29 remained in this area and yielded at the rate of 232 lbs. per acre.

(*g*) *Other Distributions.*—The seed of S.P.20 grown at Labori and Kadunguru in the previous season was supplied to the county of Usuku in the north of Teso District. Under the most unfavourable conditions a yield of 189 lbs. per acre was realised, which ranks as the third highest yield for that area in the last ten years. A 6-acre observation plot of S.P.102 was tried at Nakabango in Busoga District, but no other distributions were made.

(9) *Spinning Tests.*

(*a*) *Empire Cotton Growing Corporation.*

Samples of the 1937–38 crop were submitted to the Shirley Institute by courtesy of the Empire Cotton Growing Corporation. The following is a general summary of the results.

Count × Strength Constants.

Variety.	Where grown.	at 40's.	at 50's.	at 64's.	Highest Standard Count.	Brokers' Valuation.*
S.G.29	Serere ..	2,261	2,061	2,009	61	50 on
S.P.84	Serere ..	..	2,160	1,981	61	60 on
S.P.102	Serere ..	..	2,077	1,899	56	60 on
N.17.M2 ..	Serere ..	..	2,173	1,849	57	125 on
N.17	Busoga ..	2,149	1,989	1,773	49	..
SP.84	Busoga ..	2,132	1,910	1,810	48	..
S.P.102	Busoga ..	2,070	1,853	1,756	43	..
N.17	N. Province ..	..	2,033	1,899	53	..
S.P.84	N. Province ..	2,208	1,951	1,911	52	..
S.G.29	Bukedi and Teso	..	2,090	1,886	55	..
S.P.84	Bukedi and Teso	..	2,128	1,900	57	..

*Based on January, 1939, American Middling Futures at 4·97d.

(*b*) *Indian Central Cotton Committee.*

The following is a general summary of the report on cottons submitted from Serere.

Count × Strength Constants.

Variety.	Where grown.	at 30's.	at 40's.	at 50's.	Brokers' Valuation.*
S.G.29	Serere ..	2,101	1,885	1,699	Rs. 105 on
S.P.84	Serere ..	2,180	1,860	1,724	Rs. 100 on
S.P.102	Serere ..	2,049	1,824	1,656	Rs. 108 on
N.17.M2 ..	Serere ..	2,284	2,036	1,919	Rs. 90 on

*Based on April/May, 1938, Broach at Rs. 157.

The brokers' valuation of N.17.M2 seems anomalous, especially when compared with the valuation given by the Liverpool brokers.

Eleusine Millet.

A variety trial was conducted, comprising seven varieties randomized in eighteen blocks.

Variety.	Yield in Head lbs. per acre.	Yield of Grain lbs. per acre.	Threshing %
Engomu	2,571	1,581	61·5
Emiroit	2,384	1,506	63·2
Engenyi	2,344	1,351	57·6
Ekwakoit	2,318	1,396	60·2
Okiringi	2,089	1,207	57·8
Emoru..	2,051	1,064	51·9
Okwang	1,785	962	53·9
Significant Difference ..	249	185	not calc.

With the exception of the low yielding Okwang the results are very much at variance with those of the two previous seasons.

Ekitu.—Counts of *ekitu* or wild heads reveal that there is no variation between varieties but considerable variation between blocks. *Ekitu* would therefore seem to be determined, or partly determined, by environment.

Progeny rows were planted as usual, but they were damaged by locusts (*Locusta migratorioides*) and it was not possible to do more than harvest enough grain to continue the programme. The investigation of the *ekitu* problem was checked for the same reason.

Sorghum.

A variety trial was conducted comprising forty varieties randomized in nine blocks. The lay-out was ambitious and a number of plots failed from poor germination and other causes. After harvesting an analysis was made of 219 plots and 6 calculated missing plots, representing 25 varieties in each of the nine blocks.

No.		Name.	Heads: lbs. per acre.	Grain: lbs. per acre.	Threshing %
Teso ..	7	Enyango	2,273	1,570	69·1
	8	Etiri	2,330	1,842	79·1
	9	Aurien	2,936	2,295	78·2
	11	Ekonokamu	2,202	1,631	74·1
	15	Kitirima	..	2,250	..
	17	Etiri	2,693	1,797	66·7
	18	Okwakoit	2,009	1,314	65·4
	22	Ekomioto	..	1,540	..
	29	Okinet	..	2,718	..
	30	Edeidei	3,639	2,582	71·0
Lango ..	1	Oryemo	..	3,261	..
	4	Enyang	5,507	4,198	76·2
	6	Asiyo atino	..	861	..
	7	Asiyo adongo	2,630	2,023	76·9
	10	Amira aboco	4,069	3,005	73·9
	11	Amira acego	1,653	1,253	75·8
	12	Okile	3,964	2,854	72·0
	15	Aib ngato	..	997	..
	16	Owien	3,423	1,872	54·7
	21	Nyang anguro	..	196	..
Kenya ..	2	Dobbs Sorghum ..	1,774	1,163	65·6
Tanganyika ..	3	Nyawawa	3,549	2,733	77·0
	5	Magohe	3,075	2,144	69·7
	7	Bukura Mahemba ..	5,125	3,760	73·4
	10	Bukura Masara ..	3,381	2,280	67·4
Significant Difference			not calc.	751	not calc.

Once again low yield and low threshing percentage appear to be correlated. It is possible that bird damage is the underlying cause of this. Otherwise there is little agreement with last year's results; this year L.4 is outstanding and T.15 is not.

Progeny rows were grown and reselections made. Also promising strains from the previous season were increased, some for grain and some for silage. Investigations into the storage properties of some of the grain varieties were begun.

Groundnuts.

A variety trial was conducted in a 9 × 9 Latin Square.

Variety.	Unshelled Nuts lbs. per acre.	Shelled Nuts lbs. per acre.	Shelling %
Bunch No. 239	1,334	725	54·3
Bunch No. 238	1,135	492	43·3
Spreading No. 183 ..	943	459	48·7
Virginia Bunch	883	552	62·6
Local Spreading	764	335	43·8
Bunch No. 244	730	392	53·7
Bunch No. 226	710	408	57·5
Bunch No. 245	677	423	62·5
Bunch No. 225	604	370	61·2
Significant Difference ..	234	155	not calc.

As last year bunch No. 239 has given a significantly higher yield than the other varieties, this time in terms of shelled nuts.

Progeny rows and increase plots were grown as usual.

Cassava.

Variety Trials planted in 1936.—A trial was planted at Abela of the same design as those described on page 124 of the Annual Report, part II,

for 1936–37. The trial suffered from the depredations of pigs (and probably also humans) and three "missing plots" have had to be calculated. The adjusted yields are:—

Varieties.	Fresh Tubers: Tons per Acre.
Smalling	12·56
Bunch of Keys ..	11·20
Brownstick ..	10·41
Bobby Hanson ..	10·30
Mugowa	9·08
Numbu	3·86
Local Teso	3·73
Nyumbezunga ..	3·53
Nodewide	2·98
Significant Difference	2·94

The results are on the whole similar to those given in the report referred to, although it should now again be noted that the high yielders are bitter and the low yielders sweet, suggesting that the sweet varieties may have been more heavily raided.

A similar trial repeated at Kumi was spoiled beyond redemption.

Variety Trials Planted in 1937.—The trials described on page 96 of the Annual Report, part II, for 1937–38 have given these results:—

Fresh Tubers: Tons per Acre.

Place.	Spacing ft	Bobby Hanson.	Smalling.	Nyumbe-zunga.	Nodewide	Local Teso.	Sig. Diff.
Serere	6×6	7·01	15·39	2·33	0·68	2·72	not calc.
Serere	4×4	14·84	17·79	6·11	2·99	4·86	6·75
Abela	4×4	7·07	7·46	2·28	1·94	3·56	2·21
Katakwi	4×4	10·11	10·37	3·26	3·23	3·28	2·13
Serere	both	10·92	16·59	4·22	1·84	3·79	3·89
Three Centres ..	4×4	10·67	11·87	3·88	2·72	3·90	2·30

The trial at Serere was severely damaged by pigs and the same doubts are raised as in the last paragraph. Palatability tests were made at Serere by a very large number of people and opinions were unanimous. Bobby Hanson was adjudged bitter and the rest sweet, Nodewide being singled out as very sweet. It is surprising to find Smalling classed as sweet, but then it is known that palatability can vary as Nyumbezunga, which is adjudged sweet in Teso, is a bitter variety in Buganda.

J. D. JAMESON,
Botanist.

(iii) REPORT OF THE BOTANIST, KAWANDA.

Coffee.

General.

1. Visits were paid to some of the districts where coffee is grown by Africans—to Kigezi, Ankole and the Masaka District in September, 1938, to Bugishu in December, 1938, and to Busongora and Bwamba in the Toro District in March, 1939: observations were made on the condition of the coffee and local problems were discussed with the Agricultural Officers stationed in the districts. It has been noted that in the case of both *Arabica* and *Robusta* coffee the health of any trees growing close to African dwellings is usually much better than that of coffee which has been planted in separate plots away from the houses: this phenomenon is especially striking in the Masaka District where there is a great contrast between the vigour of the fine old specimens of *Nganda* coffee and the short productive life of most coffee plots planted in recent years. It was suggested therefore that the production of coffee by Africans in Uganda would much be improved if they grew it as a "backyard" crop, rather than attempt to copy plantation methods. There is no direct experimental evidence to prove this opinion, which is based on extensive observation in the various coffee growing districts, but several reasons were put forward in support:—

(*a*) that the addition of household refuse to the soil is of great value to the coffee, as may be seen in the improved vigour of the trees;

(*b*) that in densely populated districts, such as Bugishu, the best land is already under crops—if uncultivated land is to be opened up for coffee, it most probably will be unfertile;

(*c*) that in many cases the land around the houses has been planted with banana gardens, and that one of the best methods of establishing coffee is to plant it in these gardens: the shade and shelter from the bananas is of great value to the young coffee plants, stimulating vegetative growth and repressing fruit production for the first few years. This is a most important point in Uganda where dieback, consequent on overbearing, is an important problem in coffee planting—it can scarcely be expected that the peasants will willingly strip the first crops of their coffee in order to benefit the future health of the bushes;

(*d*) that interplanting among bananas is the most economical method —little extra labour is required for cultivation, the ground is always covered and there is little risk of invasion by harmful grasses, especially the local "couch", *Digitaria scalarum,* which often is a limiting factor to coffee cultivation. When large plots of coffee have been planted by Africans, paid labour has to be employed and in times of low prices and small returns the plots are neglected. Unless the ground is heavily shaded, these neglected plots soon become covered with a dense growth of grasses and the condition of the coffee becomes very bad—even if the grasses subsequently are dug out, the coffee has received such a check that it will never recover its former vigour.

Mr. Thomas attended the second meeting of the Inter-territorial Coffee Research Conference at Nairobi, and contributed a short leading article on "Coffee Selection" for the East African Agricultural Journal.

Breeding.

2. After continual replanting, a fairly complete stand has now been obtained in the progeny rows at Kawanda for batch after batch of seedlings that were put out on the old house sites in the coffee area could not take root; but it appears that now, four years after clearing, the ground has become fertile for coffee: (this is a much shorter period than is required for tea, as may be seen in the Kijura area of Toro which was evacuated by the Banyoro forty years ago but where tea will not yet grow on the former house sites). The bushes planted in 1938 have grown little, owing to the drought towards the end of the year—the total rainfall for 1938 was only 35 inches—but few of them have died. The bushes planted in 1937 also were relatively stunted but by the end of 1938, they were large enough for training to be commenced. Most of the coffee, both *Robusta* and *Nganda*, that was planted in 1935 has made strong growth and borne good crops—enough to refute the belief which was current a few years ago that *Nganda* coffee was excessively slow in coming into bearing. Individual tree records (of fresh cherry) are kept and the results are summarised in the table below.

Yields (in kilograms of cherry) of Coffee Progeny Rows at Kawanda.

Progeny No.	Permanent bushes.		Temporary bushes.	
	No. in fruit.	Av. yield. (kg.).	No. in fruit.	Av. yield. (kg.).
Robusta (*erect*).				
1	40	5·07	31	6·68
2	32	6·26	17	4·81
3	42	6·24	38	6·93
4	30	3·50	25	4·44
14	41	5·39	38	5·99
227	25	4·98	24	3·43
228	37	6·38	30	4·55
Nganda (*spreading*).				
36	28	1·17	36	3·12
47	38	1·70	36	2·44
203	27	2·03	37	2·41
208	33	2·10	37	4·31
209	36	2·51	33	3·48
213	34	2·48	28	3·78
214	28	1·97	30	3·75
218	31	1·81	34	2·72
222	29	1·90	28	2·20
223	27	3·64	27	3·39
224	30	1·98	31	2·70
225	33	1·89	35	2·46
233	14	2·45	27	3·80
234	31	3·39	34	3·17
235	24	1·81	26	4·66
236	31	2·01	36	2·98
238	30	2·57	35	3·04

The permanent bushes of the erect *Robusta* types are spaced twelve feet apart and are trained on the Agobiada system, while the permanent bushes of the spreading *Nganda* types are spaced fifteen feet apart and their branches have to be tied down to stimulate a wide spreading habit: both types are interplanted with temporary bushes, of the same progenies, which have one single stem but are allowed unlimited terminal growth. The ground is uneven and the rows are not randomized and therefore statistical analysis is not possible; but the following points may be noted:—

(1) The numbers of bushes in fruit in 1938 corresponds closely to the numbers which were successfully established during the first planting

in 1935; where the numbers are small, it almost always indicates the presence of house sites, on which the coffee could not grow, while the yields of those bushes which have grown appear to be depressed.

(2) The yields of the erect types have been much heavier than than those of the spreading types—progeny No. 3, the most prolific, has borne at the rate of over sixteen cwts. of clean coffee per acre, within four years of planting (this figure includes a small irregular "fly crop" in 1937). This precocious bearing is now reflected in the state of the bushes, whose appearance is not nearly so robust as it was before fruiting commenced—many primaries have dropped off. For European estates these erect types are valuable, especially when employed for interplanting to give quick returns, but they are likely to have a short useful life when planted by Africans—they will never form such magnificient specimens as the spreading trees which retain their vigour of growth and their fruitfulness for many years.

(3) The influence of training is interesting—on the whole there is little difference between the yields of the permanent and of the temporary erect bushes but, in almost every progeny of the spreading types, tying out the branches has retarded fruit production. The spreading bushes are bearing heavy crops in the current season but it is hoped that they have now attained a size sufficient to produce the fruit without undue interference with vegetative growth. When the bushes are kept to a single stem the lower primaries grow to considerable length, branching profusely and forming a dense mass of twigs near the ground, concealing the fruit and rendering picking difficult.

3. It is common experience in Uganda that when *Robusta* coffee trees are exposed to very drying conditions, their leaves may become contorted and the edges recurved: the condition is very often seen in young plants whose root systems are not developed and which on that account are very liable to suffer from drought; even the leaves which develop after a drought may be twisted and contorted, because of the check that they have received while still in the bud stage. Owing to the conditions under which coffee has been grown at Kawanda, on a hillside fully exposed to the afternoon sun, and the marked shortage of rainfall much of the *Robusta* coffee there has exhibited the symptoms to a marked degree. The seedlings planted in 1937 and 1938, have suffered considerably and many of the bushes planted in 1935, which have had time to develop a good root system, have crinkled leaves. Both the *Nganda* (spreading) and the *Robusta* (erect) types showed the symptoms, and there are considerable differences between the degree of attack in the various progenies. The progeny rows are unreplicated, on very variable soil; therefore no great accuracy can be placed on figures, but it may be noted that, while in some *Nganda* progenies there are no bushes with badly wrinkled leaves, yet in one progeny (No. 235) 35% of the bushes have badly malformed leaves. Similarly, some of the *Robusta* progenies are little affected but in the case of No. 14 there were 12% with very contorted leaves. Some Java *Robusta* selections—Bangelan 72·01, Bangelan 124·01, Soember Azin 1·09, Soember Azin 24, Ngredjo—C.—all have suffered badly from exposure.

4. Undoubtedly, exposure is the factor which is responsible for the poor condition of the coffee trees; this statement is proved by the difference between the state of the wild *Robusta* coffee rows at Kawanda, which are unshaded but heavily mulched, and that of the same types in

the Botanic Gardens at Entebbe, which are not mulched but receive light overhead shade. The leaves of many of the wild coffees at Kawanda are very contorted—in some types, *e.g.,* that from the Itwara Forest, Toro, not a bush is normal; but all types at Entebbe are only slightly affected, although the drought there has been even more pronounced than at Kawanda. It is obvious, therefore, that the health of the trees may be preserved by shading them, and shade trees (*Albizzia marginata*) have been planted at Kawanda; not only will the shade enable the bushes to preserve healthy foliage, but also it is a necessary provision in order that they may not be killed by over bearing. It is becoming recognised that the cultivation of *Robusta* coffee without shade is not economic, and therefore, there is no special need to select types to stand exposure; undoubtedly progress might be made in that direction for, as stated above, the different progenies vary in their reaction to drought conditions; the coffees from the forest usually suffer most but there is one such type (from Kalisizo near Masaka) which is quite resistant—it is interesting to note that this coffee has very dark coppery young leaves, and that the pigment may give some protection from the sun. No clear-cut correlation between the colour (copper or green) of the young leaves and the incidence of leaf curl, however, has yet been established; but it appears that in the erect (*Robusta*) types those with relatively narrow incurved leaves suffer less from exposure than the bushes with broad flat leaves (the affected bushes of No. 14 progeny, the Java selections and the Itwara Forest coffee are all broad-leaved).

5. *Albizzia marginata* was selected as a shade tree because its value has been proved on coffee estates in Uganda—it is quick growing and forms an even canopy high above the coffee, a most desirable feature when shade is put over trees which are under observation for selection and which therefore should be grown under conditions as uniform as possible. The shade trees at Kawanda have been planted relatively closely—in the spreading coffee at thirty feet by thirty feet and in the erect coffee at twenty-four feet by thirty-six feet: these spacings were controlled by the spacing of the coffee, some of the temporary bushes having been cut out to make room for the shade trees. The *Albizzia* seedlings varied greatly in size, the bigger ones being cut back to three feet and the smaller ones to near ground level—a necessary precaution as it has been observed that any stems less than half-an-inch in diameter have died back. Most of the *Albizzia* plants have started to grow and it is hoped that they will be large enough to provide to the coffee some protection from the wind in less than a year: it will be two or three years before there is much overhead shade and, as the crowns develop, the trees may be thinned to a wider spacing.

6. It is proposed to leave unshaded the short observation rows of wild *Robusta* coffees and of *Arabica* coffee varieties which are being grown at Kawanda, in order that their growth may be compared with that of duplicate rows growing in shady conditions at Entebbe. Some varieties are making very stunted growth in the open—the unshaded plants of Mokka coffee at Kawanda are only about half the height of the shaded plants (of the same age) at Entebbe; this variety in appearance resembles somewhat *Coffea eugenioides,* which also assumes a very compact dwarf habit when exposed to full sunlight. There is relatively small variation in most *Arabica* coffee types, in comparison with the variation inside progeny rows of *Robusta* coffee; but the two rows of seedlings, of wild *Arabica* coffee from Geisha, Abyssinia, comprise a wide range of forms—obviously,

it would be advisable to obtain as large a population as possible of these coffees on which to practise selection rather than to confine attention to the more uniform commercial types.

7. Three types were added to the block of short observation rows at Kawanda—*Coffea bengalensis* (*C. Horsfieldiana*) from Java, *Coffea* sp. ("Kapagota") from the Gold Coast, and *Coffea eugenioides* from Embu, Kenya. Seed and material for cytological examination from the hybrid coffees at Kampala was supplied to Mr. L. R. Doughty, Geneticist, Amani, and Mr. Doughty himself made a visit to Uganda in February in order to make cytological examination of the fresh material from these trees: these hybrid coffees produce such small crops as to be of little economic value but if tetraploid forms could be produced (for example by the use of colchicine) they might be of great importance. During Mr. Doughty's visit he and the Botanist visited together some of the forests in Toro and in Buganda in order to study the wild coffees, their different forms and their habitats. An exhibit of the wild coffees of Uganda was prepared for the Nairobi Agricultural Show—it consisted of a map showing the distribution of the different species, of photographs of the wild plants and of pressed specimens to show their botanical characters.

Experiments.

8. In view of the transfer of the laboratories it has been necessary to discontinue records of the experiment at Kampala on the effect of different soil treatments in a plot of *Robusta* coffee on the composition of the soil and on the growth of the trees. The treatments, which were started in 1933, were continued until October, 1938, when cores were taken by means of a soil auger (three inches in diameter) in order to examine the distribution of the roots. The bushes were spaced ten feet apart and therefore five cores were taken at distances of one foot, two feet, three feet, four feet and five feet in different directions around the central bush of each plot: each core was divided into layers—0–3 inches, 3–6 inches, 6–12 inches, 12–18 inches and 18–24 inches below the surface; similar cores were also taken in a nearby plot of *Arabica* coffee, making a total of twenty-five cores, each subdivided into five layers. The pieces of root were picked out with forceps, preserved in formalin solution and mounted in lines on ruled paper; this work took so long that it was not possible to deal with a larger number of samples; on two plots—that under *Centrosema* cover and the slashed plot, which was covered with grass, considerable care had to be taken that the coffee roots only, and not those of other plants, were picked out.

9. The best method of estimating relative quantities of roots appeared to be by measurement of their length for, if they were weighed, a short piece of thick root would be much heavier than a long piece of fine feeding root; it was found impossible to divide the roots into fine feeding roots and thicker lignified ones as the two types graded into each other while the latter made up only a small proportion of the total length. In only one plot was there much variation between the length of roots in the cores at the different distances from the bushes and that was in the case of the core at a distance of one foot from the bush in the plot under cover of *Centrosema pubescens*—in order to keep the *Centrosema* from climbing up the coffee, a space about eighteen inches in radius around the stem had been clean weeded and there were many less roots in the bare soil than in the ground under cover. In all other plots, there was little difference between the amount of roots found at different distances from the bushes,

but the amounts varied greatly according to the depth below the surface, as is shown in the table:—

Plot and treatment.	Average length of roots (inches) per cubic inch of soil.				
	0—3″	3″—6″	6″—12″	12″—18″	18″—24″
A. Robusta coffee under *Centrosema pubescens* cover	9·2	3·4	2·7	1·1	0·7
B. Robusta coffee—weeds slashed	9·1	5·9	2·8	1·2	0·4
C. Robusta coffee under Elephant Grass mulch ..	38·0	11·1	3·9	0·7	0·7
D. Robusta coffee—weeds removed by hand ..	11·4	4·2	2·0	1·4	0·5
E. Arabica coffee	1·4	1·1	0·7	0·5	0·3

10. The plots were not replicated, so the results cannot be subjected to statistical analysis; but the differences are so great that some important points are evident:—

(1) The contrast between the results for the four plots under *Robusta* coffee and the fifth plot (*Arabica* coffee) shows the great difference between the root systems of the two species—under the conditions of the experiment the *Arabica* coffee had a much shorter length of root at each depth than did *Robusta*—the difference being especially marked near the surface of the soil where, under in every treatment, the *Robusta* coffee had many roots.

(2) The effect of mulching in stimulating root growth was well shown in plot C, where the lower layers of mulch and upper layers of soil were a mat of roots, whose length amounted to thirty-eight inches per cubic inch of soil. There were not marked differences between the other *Robusta* plots but on plot D, where the weeds were pulled out by hand and the soil was bare and not disturbed, there were rather more roots than under the other treatments—a striking proof that *Robusta* coffee normally is a surface rooting plant. In dry spells neither the coffee under mulch (C) nor the clean weeded (D) suffered much from drought, but on the other two plots, where the coffee roots were in competition with those of other plants, drought effects were very marked. As would be expected, the condition of the root systems of the coffee bushes was reflected in the vigour of the growth above ground; the mulched bushes made the most wood and fruited most heavily, although the bushes on the clean weeded plot were little inferior; but the growth of the coffee under *Centrosema pubescens* cover was stunted, while the bushes on the slashed plot (B) were in very poor condition, with short primaries, yellow leaves and very little crop.

Tea.

11. Visits were paid to tea estates in the Kyagwe, Mityana and Kijura areas and many problems were discussed with planters: it was interesting to note the great promise that the crop is showing in Uganda in spite of the fact that conditions do not conform to the limits laid down by the pundits—in theory the rainfall is too low and the soils are not sufficiently acid for profitable tea planting, yet in practice the vigour of the bushes and the crops produced fully substantiate the opinion of Alexander Whyte, the first botanist appointed to Uganda in 1898, who considered "parts of Uganda Protectorate as singularly well adapted to cultivation of the tea

plant". A short bulletin (Department of Agriculture Circular No. 28) was written on "Some Observations of Tea Growing in Nyasaland and Ceylon in Relation to its Cultivation in Uganda" in which were embodied suggestions concerning tea planting in Uganda, some of the more important being:—

(*a*) that more care in the selection of seed supply would be of great value in enhancing the future yields of the estates;

(*b*) that steps should be taken to build up the framework of the bushes as low as possible—most of the tea in Uganda branches too far above the ground;

(*c*) that care should be taken to preserve the fertility of the soil, firstly by the prevention of erosion—the construction of small trenches and bunds above the trenches, which is so cheap and effective in Nyasaland, should be a method of erosion control well suited to the tea areas of Uganda; and secondly, that the problems of manuring should be studied—it is much better to preserve the initial fertility of the soil rather than to have to build it up again after it has been lost.

12. Blanks in the segregated plots of Betjan and Dhonjan jats at Entebbe have been filled and the plants of Betjan have made excellent growth—much stronger than that of the Dhonjan. Two more small plots, each of about one hundred plants at a spacing of fifteen feet triangular, have been put out at Kawanda to be a source of seed supply of the Dangri and Rajghur jats: in order to prevent much crossing between the jats, the former has been put near the swamp in the west corner of the estate and the latter over a mile away on the north boundary of the seed farm—the plots are thus separated as far as is feasible from each other and from the tea experimental area, which is on the eastern side of the estate.

13. One tea experiment also was planted at Kawanda—a combined variety and spacing trial comprising six jats—Betjan, Dhonjan, Dangri, Rajghur, Dahootea and Kalline (the last two are the best of the types introduced by the department some years ago)—at spacings of four feet, four-and-a-half feet and five feet triangular. The layout of the experiment was complicated by two facts—firstly, that many seedlings of some jats had been killed by eelworm attack in the nursery beds—it was necessary therefore to omit the square spacings which were to be included in the experiment as originally designed; and secondly, that as the plots had to be fitted between large carving contour bunds, they could not be laid down in a compact block—each plot therefore was made relatively large (75 feet by 49 feet) in order that when the areas for plucking (one-twentieth-of-an acre) are marked out in each one, there will be at least one row of plants around the outside to allow for border effect. Holes were made to a depth of eighteen inches and planting was started at the end of April but the weather became so dry that it was discontinued after two or three days; however, the rains resumed in early May and the conditions in that month were favourable, though June was very dry. The seed from which the tea plants were raised was sown at the end of December, 1936, with the intention of planting the experiment in 1938; as it was necessary to delay planting for a year, the plants, in spite of the relatively poor soil of the nursery, were very large. The stems were cut down to three inches above ground level, the small roots were trimmed off and the plants put out as bare "stumps": they were planted very firmly and shaded and almost all of them appear to be growing.

Fixed Oil Plants.

Oil Palm.

14. Progeny rows of the best palms at Kampala raised from seed of a selection at Serdang F.M.S. were established at Entebbe in order to complete the plot there and seed of these palms also was forwarded for trial in Tanganyika. The results of the oil palm recording at Entebbe are included in the report on the Botanic Gardens.

Castor Seed.

15. In order to facilitate selection, the Castor Seed was sown on a plot of very poor soil but nevertheless some progenies yielded well. Three types from Trinidad also were grown at Kampala; they did not yield as well as the local strains but, as the differences may have been due to later sowing, the best of them are being tested against the most prolific of the local types at Kawanda this year. Seed of some of the 1937–38 selections was supplied for trial in Zanzibar.

Essential Oil Plants.

Palma Rosa Grass (*Cymbopogon martini*).

16. Seed was introduced from Amani and the plants raised from it made strong growth in spite of the fact that they were badly attacked by rust. Little interest is being taken in essential oil plants in Uganda as it is improbable that they will yield much profit; but steps are being taken to plant small plots of all types at Kawanda, in case they should ever be required.

Spices and Condiments.

17. Small plots of Japanese Chillies, both large types and small types, were grown at Kampala and made much better growth than those of the previous year; selection of the best plants was continued. The Vanilla at Kampala is making good growth, in spite of the poor soil of the plot on which it is planted: some trials of pollination were made and a few vines produced good fruits. A plot of *Gliricidia sepium* has been planted in the Botanic Gardens, Entebbe, on which Vanilla may be grown when the Kampala Plantation is finally abandoned; it seems that conditions at Kawanda are too dry for the crop to flourish there.

Fibres.

Abroma Augusta.

18. Whenever the plants reached the flowering stage, the stems were cut and the bark retted in order to obtain a large sample of fibre; but it is obvious that yields fall off rapidly as the plants grow older, at any rate on the poor soils on which the crop is grown at Kampala.

Manila Hemp Musa Textilis.

19. As the clumps of *Musa textilis* planted at Kampala in 1935, appeared to have reached the right stage of growth, in August, 1938, some of the bigger stems were cut down and the fibre extracted. The yields were not good—twenty clumps at a spacing of twelve feet by twelve feet produced only twenty-five fully grown pseudostems, which yielded about twenty pounds or fibre. The report from the Imperial Institute was not encouraging—"The sample is lacking in the usual lustre and strength of Manila Hemp. The cleaning needs to be more regular and complete from root to tip end. If these defects can be remedied the quality would be

equal to ordinary G. Grade, to-day's value of which is approximately £19 10s. per ton." This report, together with the cost of preparation, which greatly exceeded the value of the fibre, indicates that this variety of Manila Hemp is not of much promise in Uganda; other varieties might be better but their introduction, unless they have been grown in strict quarantine, would entail great risk of the introduction of Panama Disease.

Grasses.

20. The living collection of grasses at Kampala was maintained and one or two additions of species of potential economic value have been made. Dr. Pole Evans, who passed through Uganda on his way back to South Africa after visiting Kenya to report on soil conservation measures, was supplied with material of many of the types grown at Kampala for trial in South Africa. Mr. A. S. Thomas accompanied Dr. Pole Evans and his party through Uganda and also devoted attention to collecting grasses on other safaris; a short trip was made to South Karamoja in June in order to study grasses in that district as they were little represented in collections. Several Agricultural Officers are keen students of grasses and therefore our knowledge of the grass flora of Uganda is becoming much more extensive—about four hundred species have already been recorded and others are being added to the list, while the discovery of new species is by no means uncommon; a knowledge of the taxonomy of grasses is an essential preliminary to studies of grazing problems.

Fruit.

21. The orchard plot at Kawanda was planted up in October with three of each of the good introduced varieties of Citrus fruits, budded on Rough Lemon stocks, which have proved to be the type best suited to Uganda conditions. Two or three specimens of all the other desirable types of fruit trees also were planted; blanks were infilled in April and more recently introduced fruits were added; the plot now contains twenty-seven types of Citrus, (including seedling forms) and about fifty species and varieties of other fruits. Suckers of fifty varieties of plantains and bananas from Kampala have been planted in an adjacent plot. It was found that the fruit plot was exposed to a strong drying wind and therefore, in order to give protection to the young trees, temporary hedges of Pigeon Pea have been planted along the contours; to provide permanent shelter, two cuttings of each of eighteen local varieties of figs have been planted on the bunds through the plot.

Horticulture.

22. Assistance was given to the Plantation Manager in the supervision and lay-out of the Botanic Gardens, Entebbe and an article on the gardens was published in the *East African Agricultural Journal*. The chapter on "Gardening in Uganda" was revised and extended for the second edition of "Gardening in East Africa" which is to be published soon. The Botanist had the honour of judging at the Kitale (Kenya) Rose Show and the Entebbe Flower Show.

Herbarium.

23. The herbarium was transferred from Kampala to the Kawanda in November and the additional cubboard space permitted some of the congestion to be relieved; the families were spaced out to allow for future expansion and the grasses were re-arranged to the classification of Hubbard in "The Families of Flowering Plants, Vol. II" by Hutchinson.

Introductions.

24. Plants of economic importance introduced included.

Seed of *Carludovica palmata, Cymbopogon martini, Pimenta acris* and *Canarium commune;* plants of *Piper nigrum* and *Garcinia mangostana* from Amani.

Plants of Alphonse Mango, Stoneless Zizyphus, seedless Guava, seedless Pomegranate, Tondli Cucumber and Bhokri Grape Vine: seeds of vegetables, pulse crops, etc., from the Imperial Agricultural Research Institute, New Delhi.

Plants of Bread fruit, Star Apple, *Dillnia indica, Monstera deliciosa* (var), *Pimenta acris* from the Department of Agriculture, Zanzibar.

Seeds of *Phaseolus vars., Pawpaw vars.,* and *Castor vars.,* from Trinidad per Mr. E. J. Gregory.

Grateful acknowledgment is made of the kindness of those who supplied plants and seeds and to the Director and staff of the Royal Botanic Gardens, Kew, for determinations of herbarium material.

A. S. THOMAS,
Botanist.

(iv) REPORT ON THE BOTANIC GARDENS, ENTEBBE.

Meteorological.

With the exception of 1929, 1938 was the driest year reported at Entebbe since records were started in 1900; the total rainfall was 42·53 inches, which was about one inch more than the total for 1929, but approximately seventeen inches below the average. Rain fell on 169 days and the highest fall was 1·57 inches on April 22nd; while the first half of the year was relatively moist; there were periods of prolonged drought from June onwards. In consequence, the spring in the fernery, which very seldom fails, was reduced to a mere trickle by the end of the year and for some weeks at the beginning of 1939, the flow stopped altogether.

The mean maximum temperature was 77·9°F and the mean minimum was 63·4°F, both figures being 0·1°F higher than usual; the highest temperature—87·2°F—was recorded on February 21st and the lowest—58·2°F—on August 5th.

Crops.

Oil Palm.

Routine recording of the bunches of fruit borne on the best of the older palms (Semliki valley type) was continued but it appears that none of these palms will ever be very productive.

The younger palms, raised from seed of Calabar selections, which were planted beside the old palm plot in 1934, however, are showing much

promise: every one of the palms fruited, producing from one to twenty-five bunches each. The total number of bunches (from twenty palms) was 227 and the total weight of fruit was 447½ pounds; palm No. 340/2 gave the highest yield, 107 pounds of fruit, a good record for a palm less than five years old.

The progeny rows raised from the best of the Semliki type palms, also planted in 1934, did not yield nearly so heavily as the Calabar seedlings, for only eleven out of sixty five palms produced fruit, giving a total 84 bunches containing 266 pounds of fruit; the progeny of palm 12 is the best, one of them (12/3) yielding 81 pounds of fruit.

Fifteen seedlings from the best of the Malay palms at Kampala were planted out and seedlings of two other good Malay palms were raised to complete the plot. On account of the dry weather, some of the young palms died but the older palms appeared to benefit from the drought as they are growing on a low lying plot which in wet seasons becomes water-logged, in spite of the large drains constructed through it.

Hydnocarpus species.

Hydnocarpus Wightiana continues to yield much more heavily than *H. anthelmintica*—eighteen trees of the former produced 3,497 fruits, while fifteen trees of the latter bore only 205; some trees of both species produce only male flowers. Many trees of *H. anthelmintica* are looking very yellow, although large spaces around them have been cleared of grass and mulched, for the soil at the top of the plot is very thin, overlying a compact sheet of ironstone.

Tea.

Blanks in the plots of Betjan and Dhonjan jats at Entebbe and Kitabi respectively were filled in May; almost all of the plants were successfully established but, owing to the very dry weather in the second half of the year, they made little growth.

Coffee.

The observation rows of wild *Robusta* coffee types and *Arabica* coffee varieties also suffered from drought; heavy dressings of wood ashes were given to each bush and their health in consequence improved considerably; while, as they were growing in shade, the leaves of the *Robusta* coffees were not crinkled as in the case of the exposed bushes at Kawanda.

Spices, Drugs, etc.

One addition was made to the collection—*Croton tiglium;* most of the other species made good progress though one or two plants died of root disease.

Some additional land next to the drug plant collection was taken over and there is now a continuous strip which will be planted with economic plants—vegetables, condiments, essential oil plants, drugs, spices (including a plot of Vanilla) Betjan tea, wild *Robusta* coffee types and *Arabica* coffee types. As this land is on a steep slope it has been provided with contour ditches and bunds above the ditches, which are stopping soil wash and which, in time, will build it up into a series of terraces.

The vines of Pepper (*Piper nigrum*) planted on the trees of a plot of Para rubber at the south side of the gardens, continue to flower but have set no fruit: the Director of the East African Agricultural Research

Station, Amani, at the end of the year kindly forwarded rooted cuttings of a fruiting strain of *Piper nigrum* which have been interplanted on that plot.

Fruit.

Most trees made little growth owing to the drought; the Mangosteen near the fernery produced a second crop and it is hoped that it will fruit annually. The only notable additions to the fruit collection that were successfully established were the Durian (*Durio Zibethinus*) and *Tacsonia mollissima.*

Nursery.

Distribution of plants.

The dry weather made the work of propagation difficult and, by the end of the year, stocks of many plants were low. The quantity of plants distributed, however, was more than in 1937 and amounted to:—

	Plants.	Clumps.	Packets of seeds.
Economic	1,552	..	9
Decorative	3,205	159	213
TOTAL ..	4,757	159	222

In addition, nearly four pounds of *Cinchona Josephiana* seed were supplied to a local estate where the crop is being planted on a considerable scale.

Compost making.

Most of the large bulk of leaves swept up in the gardens is rotted down in the nursery; in July experiments in collaboration with the Chemist, Kampala (Dr. Griffith), were initiated to test the value of different proportions of cotton seed in composting the leaves. The heaps were turned and watered in order to stimulate the process which was complete by the end of October. Tests were made of the effect of the compost on plants in beds but the excessively dry weather prevented the full demonstration of its value. A joint paper on this work by the Chemist and the Plantation Manager was written for the *East African Agricultural Journal.*

Decorative Section.

Flower Beds.

Two more beds at the top of the gardens were filled in and grassed over, for it is now the policy to group all herbaceous plants in the long double border near the nursery. Owing to the drought this border did not provide a display as good as was expected; the large collection of Cannas in the beds nearby also suffered greatly—in October they were dug out, the beds manured and the corns divided and replanted but they made little growth before the end of the year.

Trees and Shrubs.

The dry weather caused some very profuse flowering—among the trees that were conspicuous were *Cassia javanica, Cassia spectabilis, Monodora myristica* and *Schizolobium excelsum.* Some of the shrubs introduced in recent years also made a good show, notably *Bougainvillea var.* Mrs. Maclean, *Tibouchena semidecandra, Holmskoldia sanguinea* and *Ixora congesta;* among climbers *Petrea volubillis, Thumbergia grandiflora* and its white variety were outstanding.

A considerable number of new introductions were planted out while in the section at the south of the gardens, which is reserved for native plants, a collection of varieties of native figs (especially *Ficus Thonningii*) was planted; cuttings of about forty varieties were put out but, on account of the drought, some failed to root.

The clumps of Bamboo (*Bambusa vulgaris var aurea*) continue to flower and die, causing gaps to appear in several places in the lower part of the gardens. Repeated searching has revealed no seed production.

Orchids.

The orchid flora of Uganda is extensive, although many of the species have inconspicuous flowers: a commencement was made to build up a living collection of indigenous orchids on a group of trees by the lake. A number of forms of *Ansellia* from different localities was put on one tree but it was not possible to group all the others according to genera as they were not in flower and many forms collected were not represented in the herbarium. The orchids, like so many other plants, suffered from the dry weather—in spite of repeated syringing, many of them were slow to produce new roots.

Labelling.

A card index of the plants in the gardens has been prepared by the Botanist, Kawanda, and the names of all new introductions are added when they are planted. From the index cards the names, families, country of origin and date of planting are printed on white Xylonite labels in black Duco paint; such labels have been used since 1935, and show promise of lasting well, with occasional repainting: they are, however, rather fragile and some have been wilfully damaged by visitors.

Entebbe Flower Show.

An exhibit, consisting mainly of tropical fruits but with a few uncommon plants to give colour, was staged at the Flower Show which was held at Government House and, as in former years, some newly introduced plants were supplied as prizes.

Roads and Drains.

The usual attention was devoted to the upkeep of roads and drains and some extensions were made.

An important development was the realignment and rebuilding of the drain to carry the storm water from Entebbe township through the north side of the gardens down to the lake.

Introductions.

Grateful acknowledgement is made to all those government departments and private individuals in Kenya and in other countries who kindly supplied plants and seeds to the gardens; sixty-four species and varieties of plants and forty-seven packets of seeds were acquired on, an exchange basis, while forty-seven varieties of garden plants were purchased from Kenya.

P. CHANDLER,
Plantation Manager.

REPORT ON THE PROVINCIAL PROGRAMME OF EXPERIMENTAL WORK.

This section has been compiled from the reports received from the Senior Agricultural Officers for the Eastern and Western Provinces and from the Senior Botanist. It includes the work done on Arabica coffee at the Bugusege Plantation and observations on experiments with a variety of crops at the Ngetta Farm in Lango District and the lesser stations at Kyembogo in Toro and Kachwekano in Kigezi. Most of the field experiments with Robusta coffee are situated at the Bukalasa Experiment Station.

A. Cotton.

Variety Observation Plots in Toro

Object.—To observe the behaviour of improved strains of cotton, bred for the Eastern Province and Buganda, when grown in Toro District.

Lay-out.—Three early maturing varieties grown in single plots, each of 10 rows of 50 plants at 3′ × 1′ spacing at two centres in Toro yielded as follows:—

Results.—

Variety.	Yield expressed as percentage of the control.	
	Kyenjojo.	Kyembogo.
S.P.84	170	Failed.
B.P.52	85	Yields not
S.P.102	90	worth
Local	100	recording.

The plots were sown in the last week of July (1938) and S.P.84 was ready for picking in January. This variety (S.P.84) suffered less from diseases than the other cottons and the main reason for its superiority is believed to lie in its earlier maturity.

Sowing Date Demonstration Plots in the West Nile District.

Object.—To demonstrate to West Nile cultivators the advantages of early planting and close spacing of cotton.

Lay-out.—Single plots of equal size planted at monthly intervals.

Results.—The yields for two seasons have been as follows:—

Yields per Acre.

Centre.	Season.	May.	June.	July.	Aug.	Sept.	Mean.
Nebbi	1938/39	..	832	516	172	96	404
	1937/38	1,044	716	588	284	..	658
Aringa	1938/39	..	944	572	408	156	520
	1937/38	548	404	444	404	..	450

The yield figures are also of interest in that they are more than twice those obtained by cultivators on their own plots.

Cotton and Groundnuts Interplanting Experiment, Serere.

Object.—To observe further the effect of different planting dates of each crop and the effect of the number of rows and varieties of groundnuts. This experiment is an elaboration of the previous year's experiment carried out at Serere.

Lay-out.—A $3 \times 3 \times 3 \times 2$ factorial design comprising the following treatments:—

Cotton shade.—May, June and July sowings.
Groundnuts.—1. Bunch versus spreading varieties.
„ 2. 0, 1 and 2 rows interplanted.
„ 3. Planting at the same time as cotton, 10 days after cotton, and 20 days after cotton.

Results.—Yields are recorded separately for each treatment.

Cotton Yields.—(In pounds per acre of first quality seed cotton).

(*a*) May sown ... 492 lbs.
June „ ... 567 „
July „ ... 452 „
The yield from June sowing is significantly highest.

(*b*) Cotton not interplanted ... ... 479 lbs.
„ interplanted with 1 row groundnuts ... 520 „
„ „ „ 2 rows „ ... 512 „
Differences are not significant.

(*c*) Cotton and Groundnuts planted at the same time ... 501 lbs.
Groundnuts planted 10 days after cotton ... 502 „
„ „ 20 „ „ „ ... 508 „
Differences are not significant.

(*d*) Cotton interplanted with bunch groundnuts ... 517 lbs.
„ „ „ spreading groundnuts ... 490 „
The difference is not significant.

Groundnut Yields.—(In pounds per acre of unshelled nuts).

(*a*) May sown ... 229 lbs.
June „ ... 76 „
July „ ... 23 „
The yield from May sown is significantly highest.

(*b*) 1 row of bunch groundnuts ... ... 92 lbs.
2 rows of bunch groundnuts ... ... 224 „
1 row spreading groundnuts ... ... 77 „
2 rows spreading groundnuts ... ... 82 „
Two rows of bunch groundnuts are significantly better than one, but the same is not true of the spreading type.

(*c*) Planted at the same time as cotton ... 194 lbs.
„ 10 days after cotton ... ... 101 „
„ 20 „ „ „ ... ... 61 „
Planting at the same time as cotton is significantly better than planting later.

(*d*) Bunch type ... 158 lbs.
Spreading type ... 80 „
Bunch type is significantly better than spreading.

Conclusions.—Late planting of groundnuts is unprofitable. Cotton yields are improved by groundnuts being interplanted.

B. Robusta Coffee.

1. Shade and Cover Crop Experiment at Bukalasa (1929).

Object.—To test the effect of two types of shade, permanent and temporary, as compared with no shade, the three treatments being combined with clean weeding and continuous cover cropping.

Permanent Shade.—Gliricidia maculata.

Temporary Shade.—Bananas.

Cover Crop.—Centrosema pubescens.

Lay-out.—6 × 6 Latin Square.

Results.—This experiment was established in 1929 and the first crop occurred in the 1932–33 season. The second and fifth crops were very heavy and after the latter many of the trees had to be stumped. This has caused recent yields to be irregular. There is, however, no major change in the relation of the aggregate yields as recorded in the 1938 report. That is to say "No shade" remains better than Gliricidia and Banana shades and Clean Weeding is better in the aggregate than Cover Crop. The 1938–39 yields, however, show that Cover crop is catching up.

Yields of Fresh Cherry (Cwts. per Acre).

1932—1939.

Treatment.	Clean Weeding.	Permanent Cover Crop.	Totals.
No Shade	508	470	978
Gliricidia Shade	442	442	884
Banana Shade	462	390	852
Totals	1,412	1,302	2,714

Yields of Fresh Cherry (Cwts. per Acre).

1938—1939 Season.

Treatment.	Clean Weeding.	Permanent Cover.	Totals.
No Shade	16·6	20·2	36·8
Gliricidia Shade	13·2	18·0	31·2
Banana Shade	13·4	18·2	31·6
Totals	43·2	56·4	99·6

2. Ground Treatment Experiment at Bukalasa (1932).

Object.—To compare the yields of Robusta coffee obtained under the the following ground treatments:—

(*a*) Clean Weeding.

(*b*) Full Elephant Grass Mulch.

(*c*) Permanent Cover Crop (*Centrosema plumeri*).

(*d*) Weed Cover—selective weeding.

Lay-out.—4 × 4 Latin Square.

Results.—Owing to the divergent yields between plots caused by stumping, logarithmic transformation has been used in analysis, which makes it difficult to present significant differences. In the aggregate, however, all differences are significant.

Yields of Fresh Cherry (Cwts. per Acre).

	Annual full Mulch of Elephant Grass	Clean Weeded.	Cover Crop (*Centrosema*).	Weed Cover.
1934/35	30·6	29·6	9·4	7·8
1935/36	102·6	105·6	40·4	20·0
1936/37	113·2	72·8	75·8	64·4
1937/38	125·0	118·2	83·6	60·4
1938/39	99·0	55·8	54·8	35·6
Five Seasons ..	470·4	387·0	264·0	188·2

The clean weeded series has been hampered by one plot which lies near to an outcrop of quartzose rubble. In this plot a disproportionate number of trees has been stumped. Even so the main trend of the experiment namely, the superiority of the mulched plots, is sufficiently evident.

3. Shade and Ground Treatment Experiment at Bukalasa (1934).

Object and Lay-out.—To observe the effect of various ground treatments and of cotton seed on shaded and unshaded Robusta coffee. The treatments are:—

(*a*) Mulch.
(*b*) Alternate row mulch.
(*c*) October–March Cover Crop.
(*d*) Clean Weeding.

These four treatments are arranged in five randomized blocks, half of each block being shaded with *Gliricidia maculata* and half of each plot being manured by applying one petrol tin full of rotted cotton seed to each tree *per annum*. The ground treatments were applied in 1937. Cotton seed was first applied in 1935.

Yields of Fresh Cherry (Cwts. per Acre).

	1936—37.	1937—38.	1938—39.	Three Seasons.
No Shade	8·6	33·8	52·4	94·8
Gliricidia Shade	7·2	33·0	42·6	82·6
Significant Difference	..	..	..	..
Clean Weeded	8·6	40·6	46·2	95·4
Full Mulch (Elephant Grass)	8·8	25·2	61·2	95·2
Alternate Row Mulch	7·0	34·6	50·4	92·0
October—March Cover (*Mucuna*) ..	7·2	33·2	31·8	72·2
Significant Difference	..	6·8	8·8	11·2
No Manure	5·8	28·8	48·0	82·6
Cotton Seed (petrol tin per tree per annum)	10·0	38·2	46·8	95·0
Significant Difference	1·8	2·8	..	6·8

The interactions of season with ground treatment and manure are significant. In addition the following two-way table shows significant differential responses.

Yields of Fresh Cherry (Cwts. per Acre).

	No Shade.	*Gliricidia.*
Clean Weeded	102·8	88·0
Full Mulch	94·8	95·8
Alternate Row Mulch ..	107·0	77·0
October—March Cover ..	74·6	69·8
No Manure	92·6	72·6
Cotton Seed	97·0	92·8

The alternate-row mulch is better than full mulch in the open, and worse under shade. This result is somewhat obscure.

It is evident that shade is restraining yield in the absence of manure, and furthermore that the response to manure is considerable under shade but negligible in the open. The lower table therefore exhibits two distinct effects, which need to be carefully distinguished. The two effects together account for the fact that there is no over-all response to shade.

4. Shade Demonstration Plots at Bukalasa.

Lay-out.—Six large plots the half of each plot planted with *Robusta* 10 ft. × 10 ft. and the other half with *Nganda* 15 ft. × 15 ft. triangular planted in 1935.

Shades (*a*) No Shade.
(*b*) Natural Shade.
(*c*) *Ficus* (barkcloth).
(*d*) *Erythrina* sp.
(*e*) *Leucaena glauca.*
(*f*) *Albizzia marginata* and *Cordia* sp.

These plots are maintained for observation purposes.

5. Robusta Coffee in Bugishu.

Robusta Coffee.—Owing to the overbearing and subsequent die-back of coffee at low elevations in Bugishu, shade is being tried as a remedy. In case this fails, however, observation plots of Robusta (Nganda) coffee have been planted in eight localities at various elevations between 4,000 and 5,000 feet, so that information may be available, should shaded Arabica fail to maintain its quality and production.

6. Shade and Variety Experiment, Wanyange, Busoga (1934).

Object.—To compare the erect and the Nganda types of Robusta coffee under Busoga conditions and to observe the effect of shade on both types.

Lay-out.—5 blocks of 4 plots.

Results.—This experiment was planted in 1934 *Gliricidia* being used in the shaded plots. Owing to infestation by mealy bug *Gliricidia* was taken out in 1937 and replaced by Giant Castor while *Sesbania* was planted at the time. The latter has now attained sufficient size to act as shade and the Giant Castor has been removed. The Castor shade depresed yields considerably, probably by root competition. There has so far been no appreciable difference between the yields of the erect and Nganda types.

7. Observation Plots of Nganda and Erect Shaded and Unshaded.

These are maintained at seven centres in Busoga as a supplement to the experiment at Wanyange. The indications are that the shaded plots tend to give a lower yield but that the trees are healthier.

C. Arabica Coffee.

I. Experiments at the Bugusege Plantation, Bugishu.

The year was a poor one for cropping, the usual fluctuation following the previous year's heavy bearing. There was also much damage by *Stephanoderes.*

1. 1928 Planted Cultural Experiment.

Object.—To compare the yields of coffee maintained under five cultural treatments as follows:—

(*a*) Clean Weeded.
(*b*) Green Manure 2 covers *per annum.*
(*c*) Banana Leaf Mulch.
(*d*) Weed cover dug in twice a year.
(*e*) Leguminous cover crop from October to March and clean weeded for the rest of the year.

Lay-out.—A 5 × 5 Latin Square, each sub-plot containing five rows of eight trees spaced 8 ft. × 8 ft.

Results.—Six crops were taken from this experiment and the aggregate yields during the period 1930—1936 showed up the inferiority of the weed cover treatment. At that time the Banana leaf mulch and the October—March cover were the most promising. But the coffee had been pruned on the single stem system, which had been proved to be unsuited to Bugishu conditions and had then been allowed to grow without terminal pruning. In 1936 the trees had got into bad condition and they were, therefore, stumped. The trees gave a small crop in 1938 and were in full bearing again during the year under review. The modified multiple stem system of pruning is now in use.

Yields of Fresh Cherry in Cwts. per Acre.

	Clean Weeded.	Two Cover Crops.	Banana Leaf Mulch.	Weed Cover.	October—March Cover.
Total 1930/31 to 1935/36 ..	320·8	283·4	319·2	222·7	334·2
1937/38	13·2	11·1	5·2	5·7	20·5
1938/39	26·2	28·9	52·3	17·0	38·8
Total for eight seasons ..	360·2	323·4	376·6	245·3	393·6

L.S.D. between totals is 32·5.

Taking the eight seasons of cropping the Banana leaf mulch and the October–March cover maintain their superiority. There were no marked differences between grading out-turns but it is interesting that the percentage of "A's" has increased by 10% in all treatments since the experiment was stumped.

2. 1932 Planted Cultural Experiment.

Object.—To compare the yields obtained from coffee under seven different treatments when pruned on a modified multiple stem system:—

(*a*) Clean Weeded.
(*b*) Green Manure—two covers a year.
(*c*) Banana Leaf Mulch.
(*d*) Weed cover dug in twice a year.
(*e*) October–March cover crop; clean weeded for the rest of the year.

(*f*) March–October cover crop; clean weeded for the rest of the year.

(*g*) *Leucaena glauca* shade with low hedges of the same between the rows, slashed back for green manuring.

Lay-out.—Five randomized blocks of seven plots in which there are five rows of six trees at 6 ft. × 6 ft., spacing.

Results.—

Yields of Fresh Cherry in Cwts. per Acre.

	Clean Weeded	Two Cover Crops.	Banana Mulch.	Weed Cover.	Oct.—March Cover.	March—Oct. Cover.	Shade.
1938/39 Season ..	0·1	2·3	3·5	0·9	5·5	0·7	4·3
Total for five Seasons to date	164·9	100·4	248·4	64·5	177·0	226·2	154·5

L.S.D. between totals = 33·9.

The Banana mulch treatment which gave the highest yields for the four previous seasons took second place to the March–October cover crop. The banana mulch, however, remains at the head of the total yields for five seasons. The weed cover and the two cover crops a year are significantly worse than all the others.

3. 1936 Planted Cultural Experiment.

Object.—Supplementary to the 1932 Cultural Experiment another experiment was laid down in 1936 to observe further the effect of altering the carbohydrate/nitrogen ratio by various methods of green manuring. The treatments are:—

(*a*) September–February cover, clean weeded remainder of year.

(*b*) October–March cover, clean weeeded remainder of year.

(*c*) November–April cover, clean weeded remainder of year.

(*d*) October–December cover, dug in green and clean weeded remainder of year.

(*e*) October–December cover, dug in green and mulched over the dry season with Banana leaves.

(*f*) Biennial Fluctuation treatment (*i.e.*, March to October cover in poor cropping years to decrease yield in following season, followed by October–March cover to increase yields in theoretically poor cropping year).

Results.—The trees came into bearing for the first time but as the treatments have not yet had time to take effect the yields are not published.

4. 1927 Planted Pruning Experiment.

Object.—To compare the yield obtained from the Single Stem, Multiple Stem, and Agobiada pruning systems.

Lay-out.—Eight randomized blocks, the sub-plots containing seven rows of eight trees spaced at 8 ft. by 8 ft.

Results.—

Yields of Fresh Cherry in Cwts. per Acre.

	Single Stem.	Multiple Stem.	Agobiada.
Season 1938/39	7·1	14·8	37·1
Total for ten Seasons ..	263·4	414·1	548·4

Least Significant Difference between totals 37·0.

In the 2nd, 3rd, 4th and 6th years of bearing the Agobiada system gave higher yields than the Multiple Stem. In the succeeding three seasons these two systems were equal but it will be observed that Agobiada has now re-asserted its superiority. The Single Stem plots have suffered many deaths but the gaps have not been filled for it is considered they have been due to the treatment. Biennial fluctuation in yield of Agobiada has proved to be less marked than with the other two systems.

As regards the size of the bean the Agobiada this year produced a larger proportion of A size than did the Multiple Stem although in the previous year there was no difference in size, and in the previous three years the Agobiada beans were smaller.

5. 1930 Planted Pruning Experiment.

Object.—To test a simple form of multiple stem pruning which may be suitable for natives to use, as compared with the Agobiada system and natural growth without pruning.

Lay-out.—Six randomized blocks of 3 plots—each plot contains six rows of eight trees spaced 8 ft. × 8 ft.

Results.—

Yields of Fresh Cherry in Cwts. per Acre.

	Natural Growth.	Agobiada.	Modified Multiple Stem.
Season 1938/39	3·3	4·0	8·3
Total for seven Seasons to date	136·4	124·0	198·0

L.S.D. between totals is 18·0.

Modified multiple stem has been consistently superior to the other two treatments since full bearing commenced. Natural growth is still better than the Agobiada system in the aggregate but for the past two seasons the yields of the natural growth treatment have been less. The natural growth trees are in fact in very poor condition.

6. 1932 Planted Spacing and Pruning Experiment.

Object.—To determine the optimum spacing for coffee of natural growth as compared with coffee pruned on a simple multiple stem system.

Lay-out.—Five randomized blocks of eight plots—

Spacing: 8 ft. × 8 ft.
7 ft. × 7 ft.
6 ft. × 6 ft.
4 ft. × 4 ft.

Pruning: Modified Multiple Stem Natural Growth.

Results.—The Natural Growth trees gave the best yields in the first cropping season, the next year the yields were equal, and in the succeeding two years the Modified Multiple Stem treatment was superior. The closer spacings gave the best crops in the first three seasons.

Yields of Fresh Cherry in Cwts. per Acre.

Spacing (pruning treatments combined).

Season.	8′ × 8′	7′ × 7′	6′ × 6′	4′ × 4′
1938/39	3·8	4·2	1·5	0·4
Total for five Seasons to date ..	148·0	159·8	189·0	247·9

L.S.D. between totals=28·5.

Pruning (spacing combined).

Season.	Natural Growth.	Modified Multiple Stem.
1938/39	2·2	2·7
Total for five Seasons to date ..	174·6	197·7

L.S.D. between totals=20·2.

The Modified Multiple Stem is now giving better yields than Natural Growth and the difference between the total yields for five seasons is significant. The wider spacings are now the best although the early success of the 4 ft. × 4 ft. and the 6 ft. × 6 ft. is still reflected in the total yields.

7. 1936 Planted Spacing, Uprooting and Stumping Experiment.

Object.—To investigate the advisability of rotational stumping of closely planted coffee, or the uprooting of alternate lines.

Lay-out.—Randomized blocks containing the following treatments:—

3′ × 3′ spacing, uprooting of alternate lines.
4′ × 3′9″ spacing, uprooting of alternate lines.
5′ × 5′ spacing, uprooting of alternate lines.
3′ × 3′ spacing, stumping in rotation alternate lines.
4′ × 3′9″ spacing, stumping in rotation alternate lines.
5′ × 5′ spacing, stumping in rotation alternate lines.

Results.—This experiment bore for the first time and as the treatments have not yet taken effect the figures are not published.

II. Other Arabica Coffee Experiments in Bugishu.

1 Variety Trial at Bududa, 1937.

Object.—To test a number of varieties of Arabica Coffee for susceptibility to "die-back".

Lay-out.—Five replications of the varieties mentioned below in plots containing five rows of eight trees:—

Bugishu Local.
Harar.
Blue Mountain.
Kenya Selected Series A.
Kents Arabica.

Results.—This trial is at some distance from Bugusege and owing to staff difficulties supervision become irregular. The small first crop was therefore discarded as the yield records were unreliable. The Harar variety has suffered more than the others from *Hemilaea* and it has lately been attaacked by *Cercospora.*

2. Observation Rows.

A collection of varieties has been kept up at Bukiiti, and observation rows of five of the varieties, at seven places varying in altitude between

4,000 and 5,000 ft., have been maintained for the primary purpose of discovering whether there is any differential resistance to die-back. At Bukiiti Harar was affected also by *Cercospora* and die-back, in some cases resulting in death. It is not known whether *Cercospora* is primary or secondary but it is most unusual for coffee to die in its first year of bearing and it is evident that Harar is unsuitable for Bugishu conditions.

D. Tobacco.

Outside the regular producing areas of Bunyoro and the West Nile District, small observation plots of air- and fire-cured tobacco were grown at three centres in Budama and four centres in Bugishu. Excellent samples of leaf were obtained from Budama, and it is now considered that this area has been proved for tobacco in the Spring. Prevalence of hail makes the success of the crop too precarious in the autumn.

The crop in Bugishu is being tried in the marginal areas of cotton and coffee cultivation. The tobacco was badly affected by Mosaic disease and trials will be repeated.

E. Miscellaneous Trials.

Sesame.—Fourteen varieties of sesame isolated from the native grown bulk were grown in observation plots at the Ngetta Farm.

Eleusine Millet.—Eleven local varieties were grown at Ngetta. Four of the Teso varieties and three from Lango were tried on the Kyembogo Farm in Toro District.

Sweet Potatoes.—Seven local varieties grown in equal sized plots at Ngetta yielded as follows:—

Variety.	Yields (lbs.).	
	1938/39	1937/38
1. "Oyogogo"	20,140	12,375
2. "Achan"	29,380	19,620
3. "Ojony"	27,690	18,036
4. "Oleke"	33,111	23,163
5. "Adururam"	18,866	11,943
6. "Adago"	11,088	14,004
7. "Anamo-Oyito" ..	11,444	12,339

Cassava.—Two trials of five varieties of cassava were laid down at Abela and Katakwi in Teso. The results will be found in the combined analysis of the Serere trials in the report of the Botanist.

Observation rows of cassava established from cuttings infected with Mosaic disease, and from healthy material, repeated the results of the previous year at Kumi by showing double the yield in the healthy rows.

Soya Beans in Bunyoro.—Single plots of "Local", "Barberton Y.1" and "R.42" sown at Bulindi on 26th April, 1939, and a second series sown on 26th May, 1939, gave excellent germination in respect of "R.42" but very poor germination in the case of the other two varieties. The "R.42" plots yielded at the rate of 3,636 lbs. per acre. Soya Beans had not previously been grown on this land. The "Local" variety took 16—18 weeks to mature against 12—14 weeks for the "R.42" and "Barberton" varieties.

Pyrethrum in Kigezi.—Single quarter-acre plots have been established at the following seven centres in Kigezi:—

Kachwekano (6,500 ft.),
Kachwekano (7,500 ft.),
Maziba (5,000 ft.),
Kanaba (8,000 ft.),
Bisika (7,500) ft.),
Mpalo (5,500 ft.), and
Nyakishenyi (5,500 ft.).

The plots were grown from seed sown during October and November, 1938. Flowering began in the second half of 1939. A single sample of flowers from the most promising plot, that at Kanaba (8,000 ft.), was favourably reported upon as regards total pyrethrins by the Scott Agricultural Laboratories, Nairobi, in September, 1939. Further samples are being forwarded for analysis as flowering occurs and observations on the growth and general behaviour of the plants are being continued.

F. Fertility and Soil Conservation.

1. Grass Regeneration Experiment at Kumi.

Object.—To compare the regenerative qualities of five grasses, planted or sown, with natural weed cover. The varieties are *Chloris gayana, Hyparrhenia dissoluta, Cynodon plechtostachyon, Imperata cylindrica, Pennisetum purpureum.*

Lay-out.—One twelfth acre plots of each grass in four randomized blocks, each pair of blocks being left under cover for a 3 or 5 year period before planting an index crop.

Results.—An index crop of cotton was taken in 1936 and the grasses were planted in 1937. The *Hyparrhenia* cover failed and the plots under this grass are now kept under Pigeon pea *Cajanus indicus.*

2. Regeneration Experiment at Kamuge.

Object.—To compare the regeneration of land under cassava with regeneration under grass.

Lay-out.—Ten 1/20th acre plots of cassava and ten 1/20th acre plots of grass, mainly Sudan Red Top, were planted in 1934 on land which had been cultivated for many years. The plots are in random pairs. There are as yet no results to record.

3. Elephant Grass Rotation Experiment at Bukalasa.

Object.—To find out the period under elephant grass fallow necessary to maintain soil fertility.

Lay-out.—There are three periods of rest under elephant grass,—two, three, and four years and a fourth treatment in which the land is allowed to revert to bush for three years. There are three years cropping with cotton, groundnuts, cotton and cotton interplanted. The lay out is a 4 × 4 Latin Square.

Results.—One cycle of cropping has been concluded and all plots are now under their respective resting treatments.

4. Tobacco–Cotton–Elephant Grass—Experiment at Bukalasa.

A test of four rotations bringing in tobacco as well as cotton, three of the rotations using elephant grass as a fallow crop and the fourth using green-manure two years in succession. The rotations are:—

	A	B	C	D
1st Year ..	Tobacco Cotton	Cotton	Tobacco Cotton	Tobacco. Cotton.
2nd Year ..	Groundnuts Cotton	Tobacco Cotton	Groundnuts Cotton	Groundnuts. Cotton.
3rd Year ..	Tobacco Cotton	Groundnuts Cotton	Tobacco Cotton	Green-manure. Cotton.
4th Year ..	Elephant Grass for 4 years.	Elephant Grass for 3 years.	Elephant Grass for 3 years.	as 3rd year and so on.

Lay-out 4′ × 4′ Latin Square.

Three of the four rotations are under elephant grass and the fourth had green manure and cotton as usual.

5. Cotton Manurial Experiment at Bukalasa.

Object.—To observe the effect on the maintenance of fertility by heavy dressings of cotton seed, by green manuring and by a combination of the two. The rotation is a typical local one—

1st Year Cotton
2nd „ Groundnuts,
Cotton

and so on. The dressing of cotton seed is 4 tons per acre and the green manure *Crotalaria juncea*. The manuring is done in alternate years starting with the first. The lay out is a Latin Square.

Results:—

Yields of Seed Cotton and Unshelled Groundnuts

for 1938–39 Season.

Treatment.	Cotton.	Groundnuts.
Control	928	866
Cotton Seed	1,140	982
Cotton Seed and Green Manure	953	939
Green Manure	996	848

This season manures were not applied, according to schedule. The residual value of cotton seed alone shows up in both the groundnuts and the cotton crops, but, as in previous years, green manure shows no residual effect. The high level of yields maintained by the control plots after 6 years of continuous cropping is remarkable more particularly so because the original soil was definitely on the poor side.

A summary of the results to date is tabulated below:—

Yields in Pounds per Acre—Cotton (Seed Cotton)—Groundnuts (Unshelled Nuts).

Season.	Crop.	Control.	Cotton Seed 4 tons per acre.	Green Manure Crotalaria juncea.	Cotton Seed 4 tons per acre plus green manure C. juncea.	Mean Yield.
1933/34* ..	Cotton ..	454	678†	554	665	588
1934/35 ..	Groundnuts ..	1,127	1,479	1,107	1,227	1,235
	Cotton ..	736	868	766	831	800
1935/36* ..	Cotton ..	902	1,014	934	1,006	964
1936/37 ..	Groundnuts ..	1,274	1,132	1,303	1,244	1,238
	Cotton ..	361	472	397	424	414
1937/38* ..	Cotton ..	584	677	603	756	655
1938/39 ..	Groundnuts ..	866	982	939	848	909
	Cotton ..	928	1,140	953	996	979
Total lbs. ..	Groundnuts ..	2,267	3,593	3,349	3,319	..
Total lbs. ..	Cotton ..	3,965	4,849	4,207	4,678	..
Mean per acre	Groundnuts ..	756	1,198	1,116	1,106	1,044
	Cotton ..	661	808	701	779	737

*Manures applied.

†Seven tons per acre were applied 1933/34 season only.

The above shows that a total of 15 tons of cotton seed applied per acre has given an aggregate increase in yield of 1,326 lbs. of groundnuts per acre and 874 lbs. of cotton over a period of 6 years; the green manure alone has given an increase of 1,089 lbs. of groundnuts and only 242 lbs. of cotton while the combination of the two has given an increase of 1,052 lbs. of groundnuts and 713 lbs., of cotton. The residual effect is interesting—the total increase in the 3 cotton crops immediately following green manure is 151 lbs. as compared with 91 lbs., in the 3 other cotton crops; whereas the 3 cotton crops immediately following the application of cotton seed have given a total increase of 429 lbs. and the 3 second cotton crops which show the residual effect, if any, have given a total increase of 475 lbs., so that the effect of the cotton seed appears to be just as pronounced in the second season as in the first.

6. Tobacco and Cotton Manurial Experiment at Bukalasa.

Object.—To test the effect of various manurial treatments on a Tobacco–Cotton, Groundnuts-Cotton rotation; manures being applied to the Tobacco crop. The three manures are kraal manure (10 tons per acre), cotton seed (4 tons per acre) and cotton seed ash (5 cwts. per acre), the fourth treatments being a fallow period of 3 years under Elephant Grass. The yields per acre of the Groundnuts and Cotton crops harvested this season were as follows:—

	Groundnuts Unshelled lbs. per acre.	Cotton lbs. per acre.
Cotton Seed	1,221	940
Cotton Seed Ash	1,467	1,076
Kraal Manure	1,310	984
Mean	1,333	1,000

The fourth treatment was planted to Elephant Grass.

This is the second crop in the second cycle of the experiment. Comment on the results will be reserved until the completion of the cycle.

7. Experiment to Test the Residual Value of Six Local Grasses at Ngetta.

This experiment, which was laid down in June, 1936, consists of six random blocks, each sub-blocked for grazed versus un-grazed, with the grass species randomized within each sub-block.

The grasses employed were:—

(1) Panicum maximum,
(2) Brachiaria decumbens,
(3) Pennisetum polystachyon,
(4) Setaria spacelata,
(5) Chloris gayana, and
(6) Cynodon dactylon.

Grazing by cattle was applied as required and observation of the behaviour of the species under the two treatments maintained during the run of the experiment.

The observations indicate that under conditions of grazing all species found difficulty in withstanding the competition of Cynodon dactylon which showed a marked tendency to encroach and colonise at the expense of the other grasses. Marked for persistence, the grasses, excluding C. dactylon, are placed as follows:—

1. Chloris Gayana.
2. Panicum Maximum.
3. Setaria spacelata.
4. Brachiaria decumbens.

Panicum maximum was erratic in its persistence to the extent that, at the end of the three years period, some plots were good while in others only a few plants were to be found. The grass exhibited its usual tufted habit.

In the un-grazed plots all grasses persisted thrughout the period with the exception of Pennisetum polystachyon. The latter practically died out in the second year.

The area of the experiment was ploughed in March and cotton planted as an index crop.

8. Model Shamba at Bukalasa.

The following yields were realised:—

Maize	...	...	1,172 lbs. per acre.
Groundnuts	...	...	1,098 lbs. per acre.
Beans	...	...	270 lbs. per acre.
Cotton	...	...	740 lbs., per acre.

In addition 328 lbs. of sun-dried cherry were obtained from 181 Robusta Coffee trees.

SUMMARY OF INCOME.

		Shs.	cts.
Cotton, clean	1,231 lbs. @ 8/50	104	63
„ „	117 lbs. @ 8/-	9	36
Maize (on cob)	72 lbs. @ ½ cent	0	36
Groundnuts	72 lbs. @ 5 cents	3	60
„	71 lbs. @ 4 cents	2	84
„	152 lbs. @ 3 cents	4	56
Beans	88 lbs. @ 3 cents	2	64
„	5 lbs. @ 2 cents	0	10
Coffee	200 lbs. @ 8 cents	16	00
„	128 lbs. @ 4 cents	5	12
	GROSS INCOME	149	21
Deduct 79 man-days labour employed @ 37 cents per day		29	23
		119	98

The balance sheet, in a year of low cotton prices, is eminently satisfactory. The most remarkable feature, however, is that in the twelfth year of continuous cropping (one shift of *Crotalaria juncea* is included in the rotation as green manure) the cotton yield is the highest yet obtained.

9. Green Manure for Cotton at Bukalasa.

Object.—To observe whether there is any effect on the yield of cotton from green manuring and if so whether it is dependent upon the time that elapses between its digging in and the time of planting of the cotton.

Lay-out.—A replicated experiment with 4, 6, 8, and 10 weeks' periods. The green manure was *Crotalaria juncea* and, for one extra treatment, Sunflower.

Results.—There were no significant differences between the various times of digging in the green manure and no significant increases in the yield of the manured plots.

Green Manure.	Period between digging in of green manure and planting of cotton.	Cotton Yields lbs. per acre.
Sunflower	8 weeks 5 days	1,387
Crotalaria Juncea	10 weeks 5 days	1,375
Crotalaria Juncea	8 weeks 5 days	1,346
Crotalaria Juncea	6 weeks 5 days	1,335
Crotalaria Juncea	4 weeks 5 days	1,424
Control		1,368

10. Permanent Manuring Trial at Serere.

Object.—To compare the effect of farmyard manure with lime as a measure for the retention of soil fertility.

Lay-out.—A 5 × 5 Latin Square was laid down in 1933 under the following rotation:—

1st Year ... Green Manure (after application of the manures).
Cotton.

2nd Year ... *Eleusine coracana.*
Cotton.

3rd Year ... Groundnuts.
Green Manure.

The green manures were *Crotalaria juncea* in 1933 and *Stizolobium* from 1935 onwards. The manurial treatments applied at three year intervals before planting the green manure in the first course are:—

1. Control; no manure.
2. Lime 2 tons per acre.
3. 10 tons Farmyard Manure per acre.
4. 20 tons Farmyard Manure per acre.
5. 30 tons Farmyard Manure per acre.

Results.—The following table summarises the results to date:—

Yields in Lbs. per Acre.

Year	1933/34	1934	1934/35	1935	1936/37	1937	1937/38	1938
Crop	Cotton	Finger Millet	Cotton	Ground Nuts	Cotton	Finger Millet	Cotton'	Ground Nuts.
Control	390	1,861	445	1,073	560	441	431	281
Lime 2 tons	332	2,372	410	983	574	608	537	363
10 tons F.Y.M. ..	390	2,403	579	1,073	755	589	859	437
20 tons F.Y.M. ..	364	2,193	567	1,143	746	608	884	421
30 tons F.Y.M. ..	283	2,399	577	1,193	798	768	1,007	410
Significant Differences ..	None	None	130	None	150	None	179	None

The 1935 groundnut figures differ from those published in the last report (page 73). The latter were incorrect in that they were treatment totals and not yields per acre.

The above table represents two complete cycles of the rotation.

Farmyard manure has given a significant positive response except on the first cotton crop of 1933/34 and although there are no significant differences among the yield records of the millet and the groundnut plots the trend towards increased returns cannot be ignored.